May 31, 2013

***Ex Parte* Notice**

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: *Connect America Fund,* WC Docket No. 10-90; *High-Cost Universal Service Support,* WC Docket No. 05-337

Dear Ms. Dortch:

On Wednesday, May 29, 2013, the undersigned and Brian Ford on behalf of the NTCA–The Rural Broadband Association, together with Gerry Duffy on behalf of the Western Telecommunications Alliance, Jeffry Smith on behalf of GVNW Consulting, Inc., and Jeff Dupree and Tatjana Curovic on behalf of the National Exchange Carrier Association (the "Rural Parties") met with Carol Mattey, Steve Rosenberg, Amy Bender (via telephone), Travis Litman, James Eisner, Craig Stroup, Rodger Woock, and Suzanne Yelen of the Wireline Competition Bureau to discuss a series of issues related to the use of quantile regression analysis ("QRA") to establish caps that limit high-cost support received by rate-of-return-regulated rural local exchange carriers ("RLECs"). A copy of materials shared with Federal Communications Commission (the "Commission") staff during the meeting is provided herewith.

Given that that the QRA model will apparently remain in effect pending additional review, the Rural Parties started the meeting by reiterating their desire, without foregoing any of their legal or appellate rights, to engage in an ongoing series of discussions with the Commission's staff regarding ways to examine, adjust, and refine the latest iteration of that model to improve its transparency, accuracy, predictability, and methodological integrity to the extent feasible under QRA. The Rural Parties highlighted once again the substantial challenge of revisiting and refining or even potentially remaking such a complex mechanism "on the fly" as the model is already in effect and data updates and study area boundary corrections are still to come. We note, however, that such an effort was contemplated by the *Sixth Reconsideration Order* and we discussed with the staff whether and to what degree this much-needed review, adjustments, and testing could be achieved this year in sufficient time to develop a more robust and stable model based upon accurate data so that RLEC efforts at making reasonable network plans for 2014 (and beyond) are neither frustrated nor undermined by persistent regulatory uncertainty.

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We then proceeded to discuss four specific issues arising out of review of the current iteration of the QRA model as outlined further in the attached materials. Key points discussed during the meeting with respect to each issue included:

Issue 1: Census Block Errors. The Rural Parties observed that errors in the mapping of census blocks to study areas could affect the accuracy of several variables, including % Urban area and Density. We indicated that we would provide further data regarding the extent of these errors and their impact in the models, but in the interim, we provided several suggestions on ways to ensure that the QRA model results are not rendered unduly inaccurate by the inclusion or exclusion of entire borderline census blocks from study areas.. We specifically urged the Commission not to treat known mistakes in mapping of census blocks to study area boundaries as "good enough" simply because a consistent process (*i.e.*, a centroid method) was used to draw all census blocks, and to instead consider thoughtful and reliable ways in which such errors might at least be minimized if not eliminated through a "further look" that involves little burden.

Issue 2: Predictability. The Rural Parties provided information regarding volatility in the QRA caps from year-to-year for all study areas. We noted that while the *average effects* might be acceptable were the Commission dealing with larger companies that served multiple study areas, the variation in *individual company impacts* was of concern and should be viewed as a warning flag with respect to the stability of the model being examined. We discussed how tests were run to isolate the effect of the percentage of undepreciated plant for each carrier on variations in the benchmarks, and how those tests still indicated a significant amount of volatility in the caps independent of any given carrier's efforts with respect to undepreciated plant. We further discussed how, even if a sizeable proportion of carriers might be "far enough below" their caps for this volatility not to be of immediate concern, it was a concern for all carriers in the longer-term (*e.g.*, as they consider decades-long capital investment and borrowing strategies) and it was certainly of concern to those carriers near the caps presently. We urged the Commission to develop a robust model through the use of increased predictability testing. We indicated that we would report back to the Commission regarding the compound effect of changes in benchmarks on individual carriers on a year-to-year basis through our own testing and analysis.

Issue 3: Modeling Options. The Rural Parties provided suggestions to the Commission on various options that could be used to test the goodness of fit of different QRA formulas, showing as one example a panel of model options that included or excluded different variables. We observed at the same time, however, that simply "dropping variables" due to statistical significance (or lack thereof) could end up eliminating the very factors that may explain a given carrier's appearance "above the caps." (This, it should be noted, is one significant reason why the use of the QRA caps as triggers for review rather than as automated support reduction machines would be more appropriate.) We also discussed other perspectives – such as how different kinds of carriers and study areas were affected by different formula variations – could inform (although perhaps not be determinative) in identifying concerns with respect to the impacts of any given model.

<u>Issue 4: Simulation</u>. The Rural Parties supplied data showing that the QRA caps in current form fail to capture would-be excessive cost outliers through the use of "hypothetical perfectly similar" test carriers. Specifically, the Rural Parties took all 726 cost company RLECs and created a series of nine hypothetical "clones" for each RLEC that varied from the original only in cost mark-up; in other words, all factors associated with each RLEC were held constant with the singular exception of the costs submitted for recovery by that RLEC and its hypothetical clones, which were marked up in 10% increments for each clone.

In running the current CapEx model with respect to these 726 cost companies and their 6,534 clones (*i.e.*, nine clones each), the Rural Parties found that the current QRA model captured the "most expensive" clones only 27% of the time. Indeed, in six cases, *the "least expensive" company* in the analysis – the original RLEC, without any cost mark-up – was hit by the QRA caps in lieu of its more expensive clones.

Moreover, to ensure that there were no issues with alleged "outliers" somehow skewing the data or any issues specific to the CapEx model, the Rural Parties ran the same simulation with the Total Cost model using only RLECs that are *not* capped by this model and their respective clones. (To be clear, because the Commission has not yet released a Total Cost model, the version used in this simulation was the same as the current CapEx and OpEx models, except that the dependent variable was combined cost.) The results of this second simulation improved just slightly, with the "most expensive" clone being capped only 33% of the time.

These tests underscore the need for reworking and additional testing of the current QRA model, as it fails not only in allowing carriers to identify their benchmarked "peers" but even in capturing with reasonable accuracy which carriers are potential "outliers" in terms of allegedly excessive expenditures. Simulation tests of this kind should be conducted with respect to any changes to the QRA model moving forward to ensure the accuracy of the mechanism.

Pursuant to Section 1.1206 of the Commission's rules, a copy of this letter is being filed via ECFS. If you have any questions, please do not hesitate to contact the undersigned.

Sincerely,

<u>/s/ *Michael R. Romano*</u>
Michael R. Romano
Senior Vice President - Policy

Enclosures

cc: Carol Mattey
Steve Rosenberg
Amy Bender
Travis Litman
James Eisner
Craig Stroup
Rodger Woock
Suzanne Yelen

QUANTILE REGRESSION

Issues Meeting

May 29, 2013

Agenda

- Introduction
- Quantile Regression Inputs
  - 1. Census block errors resolution
- Quantile Regression Modeling
  - 2. Predictable results testing
  - 3. Model options
- Quantile Regression Output – Simulation Exercise
  - 4. Simulation results suggest a problem with the "similarly situated carriers" concept, which requires testing

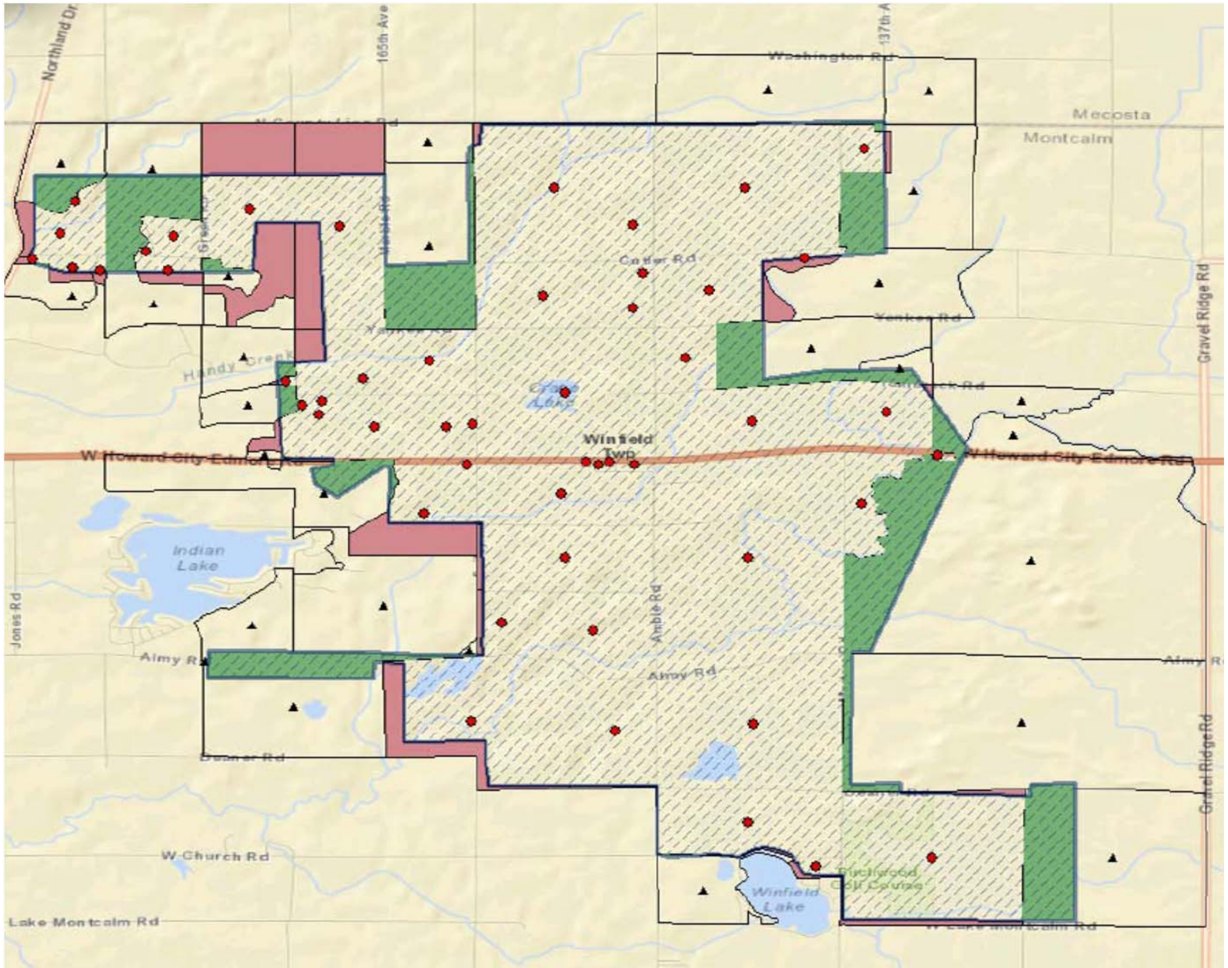
Introduction

- Associations have sought this meeting to continue a dialogue regarding lingering concerns with the current use of regression methodology to limit high cost loop support
- While Associations in the first instance do not believe a regression model—at least as currently structured—can satisfy statutory mandates of predictability and sufficiency, improvements in the current model must be sought and implemented to the extent it will continue to govern distribution of USF support
- While there are many issues, we have identified four issues for this meeting—some relate to inputs and others relate to modeling and testing results for policy
- In addition to this document, we have prepared an appendix document with additional materials for those interested in further analysis
- Associations anticipate this to be one of a series of meetings to isolate and address issues in different inputs, variables, and structural matters related to the regression formulas, in addition to continuing and related policy discussions

Issue 1: Census Block Errors

One Exchange Example

- Two overlap errors exist



Red: included areas outside exchange area

Green: excluded areas inside exchange area

Issue 1: Census Block Errors (continued)

One Study Area Example

- Census block errors can be significant

Portion Of CB Area Missassigned	CBs With Area Erronoeusly : Included	Excluded	Total CBs with Missassigned Areas	Missassigned CBs as % of All Populated CBs
More than 2 %	122	141	263	17.98%
More than 5 %	98	108	206	14.08%
More than 10 %	66	87	153	10.46%
More than 20 %	44	58	102	6.97%
More than 50 %	7	8	15	1.03%

Issue 1: Census Block Errors (continued)

- Census block errors can be significant

Household Density Profile of Populated CBs with Missassigned Portions of More than 5 %

-	Included CBs			Excluded CBs		
	Housing Units	Area	Density	Housing Units	Area	Density
Minimum	1	0.0030	0.1960	1	0.0012	0.1080
Maximum	49	21.6512	663.7890	94	24.3573	856.1870
Average	11	1.7162	71.2450	13	2.1412	91.5880
Standard Deviation	12	3.2956	138.6230	16	4.1712	185.1520

Profile of CBs With Missassigned Portions of More than 5 %

	Included	Excluded
Number of Census Blocks	98	108
Area in Square Miles	168.19	231.25
Area Overlapping with Study Area	127.21	69.54
Housing Units	1,080	1,359
Number of CBs Designated As:		
Urban	0	2
Tribal	0	0
Parkland	0	0
Estimated Missassigned Housing Units		
Maximum	1080	1359
Minimum	0	0
In Proportion to Area Misses	268	350

Issue 1: Census Block Errors (continued)

- Census block errors can be significant

Effect of Housing Units Missassignment on Density and Model Results for Different Scenarios

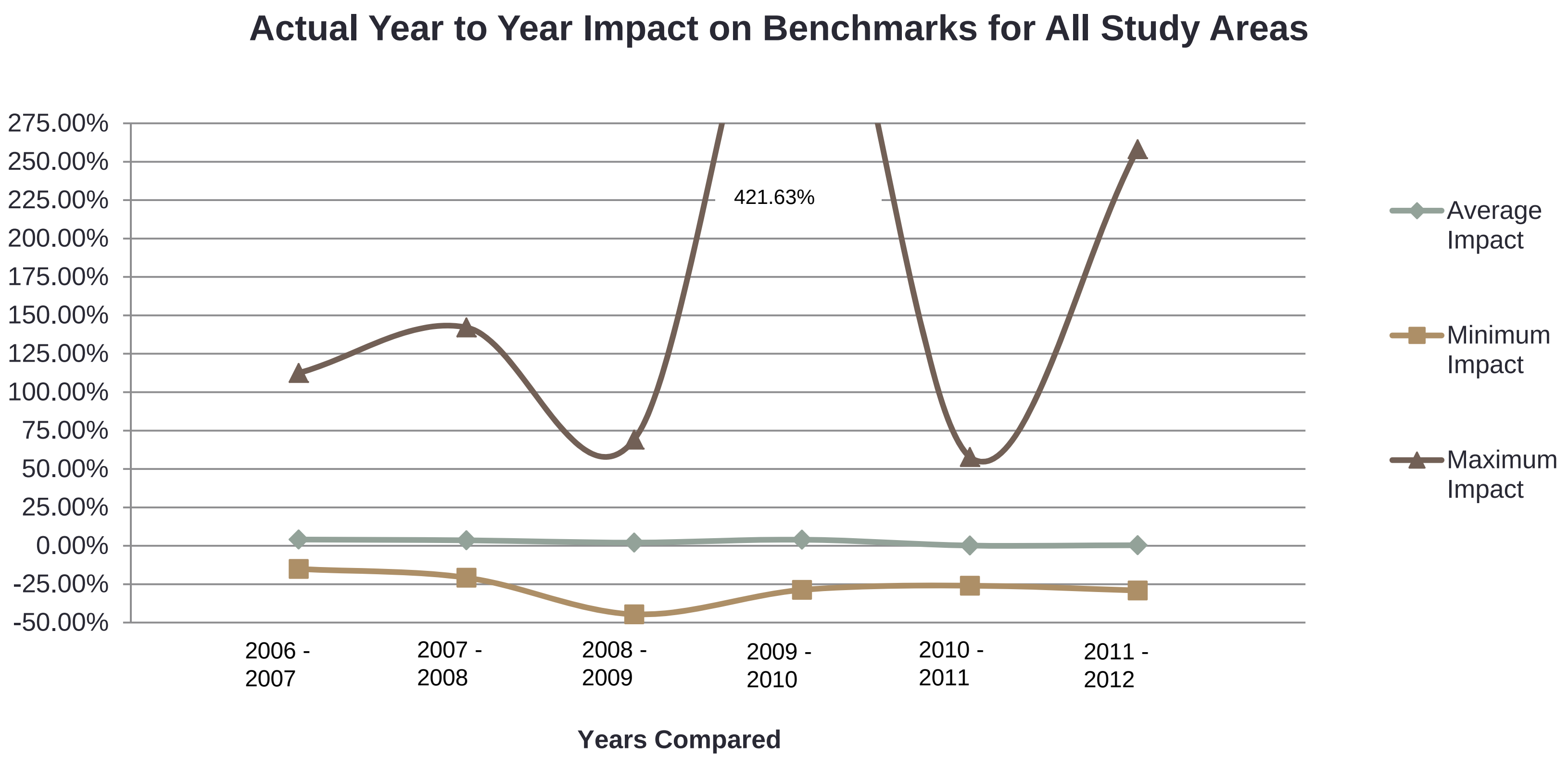
	Net Effect of Missassigned Portions On HU	Corrected Count HU	Corrected Density	% Change Density
Scenario (Excl-Incl)				
Min-Min	0	10,333	4.917828	0.00%
Min- Max	-1080	9,253	4.403820	-10.45%
Max- Min	1359	11,692	5.564623	13.15%
Max - Max	279	10,612	5.050614	2.70%
Proportional Method	82	10,415	4.956665	0.79%

Issue 1: Census Block Errors (continued)

- Possible solutions to overlap errors
  - Any solution needs to use the to-be-verified shapefiles filed with the Commission
- Methods to split the census block when necessary
  - Road miles data indicate where the roads are in a census block Roads may serve as a proxy for locations, even when road data is not reliable because they are used in a ratio
  - Geocoded locations within census blocks are available
- Both sources of information can be used to distribute locations within a census block
- Both options appear to be better than the current centroid method and better than assuming uniformly distributed population
- Improvements must be made to this critical input

Issue 2: Predictable Results

- Year to year variation of current model suggests unstable policy foundation and requires testing of new models



Issue 2: Predictable Results (continued)

- Coefficients vary in significance over time

Variable	2006	2007	2008	2009	2010	2011	2012
lnloops	0.760	0.710	0.740	0.805	0.741	0.676	0.644
lnroadmiles	-0.303	-0.305	-0.318	-0.350	-0.350	-0.217	-0.235
lnroadcrossing	0.295	0.327	0.315	0.312	0.366	0.242	0.246
lnstatesacs	-0.041	-0.037	-0.066	-0.051	-0.077	-0.076	-0.102
pctundepplant	0.014	0.016	0.015	0.016	0.017	0.018	0.007
lndensity	-0.191	-0.170	-0.197	-0.246	-0.211	-0.140	-0.147
lnexchanges	0.092	0.109	0.106	0.077	0.101	0.136	0.104
pctbedrock36	0.083	-0.052	0.169	0.034	-0.012	0.185	0.091
diff	0.173	0.262	0.201	0.183	0.122	0.136	0.112
climate	0.135	0.125	0.141	0.136	0.113	0.112	0.121
pcttriballand	0.002	0.002	0.002	0.001	0.001	0.002	0.002
pctparkland	0.007	0.007	0.009	0.010	0.010	0.011	0.007
pcturban	-0.001	0.000	0.001	0.000	0.002	0.002	0.003
alaska	-0.031	0.095	0.091	-0.219	-0.114	-0.033	0.258
midwest	0.170	0.142	0.146	0.134	0.121	0.115	0.130
northeast	0.062	0.042	0.053	-0.020	-0.049	-0.117	0.008
Intercept	7.168	7.267	7.304	7.254	7.512	7.929	8.211

Shaded gray are variables that were not statistically significant at 90% level

Issue 2: Predictable Results (continued)

- Current model is unreliable for limiting High Cost Loop Support
  - Much work is needed to achieve a predictable and stable regression model
- Predictability testing is essential step in model evaluation
- Success in developing a model that captures variance in cost per loop should be the final goal of the methodology
  - Cost per loop is the determinant of the cost of providing Universal Service
  - Cost per loop is used in determining eligibility for High Cost Loop Support

Issue 3: Modeling Options

- Models with similar goodness of fit show varying results

Parameter	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	7.9295	7.6521	8.0557	7.8984	9.4453	9.0761
lnloops	0.6761	0.747	0.7054	0.7335	0.2813	0.3383
pctundepplant	0.018	0.0174	0.0181	0.019	0.0162	0.0172
lnexchanges	0.1359	0.0912	0.1307	0.1041	0.1021	0.0794
lnroadmiles	-0.2167	-0.3373			-0.2506	-0.2121
lnroadcrossings	0.2425	0.3375			0.2481	0.2311
lnstatesacs	-0.0761	-0.0891	-0.0854	-0.0809	-0.0952	-0.0895
lndensity	-0.1396	-0.2043	-0.0843	-0.1403	-0.1929	-0.2135
pctbedrock36	0.1855		0.2743		0.287	
diff	0.136		0.1208		0.1036	
climate	0.1124	0.1283	0.1232	0.1548	0.1216	0.1409
pcttriballandland	0.0016	0.0019	0.0014	0.0016	0.0015	0.0025
pctparkland	0.0105		0.008		0.0137	
pcturban	0.0019		0.0024	0.0028	0.0004	
alaska	-0.0329		0.0858		-0.2137	
midwest	0.1146	0.1681	0.1268	0.1446	0.1799	0.1997
northeast	-0.1166		-0.1113		-0.0503	
lndensity_sq					0.0231	0.0277
lnloops_sq					0.0589	0.0529
pseudo R2 log Model	0.689	0.690	0.687	0.674	0.692	0.693
pseudo R2 Recalculated for level costs	0.726	0.723	0.726	0.702	0.698	0.693
pseudo R2 Recalculated for cost per loop	0.450	0.456	0.458	0.412	0.465	0.470

Issue 3: Modeling Options (continued)

- Modeling total cost
  - 38 carriers are impacted under every model
  - The degree of each impact varies widely
    - For example, one carrier moves from not being impacted to more than $7,000 per loop

Number of Times Impacted	Study Area Count
Never	628
Just Once	15
Twice	13
Three times	14
Four times	7
Five times	11
Always (six times)	38
At least once	98

Carriers impacted under all models

Obs	Loops	Impact Per Loop in Dollars Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Impact Spread (Max-Min)
1	167	2,884.42	3,347.12	3,422.18	3,749.64	2,802.40	3,326.11	947.23
2	217	1,422.84	1,342.81	1,635.07	1,410.01	1,282.53	1,020.33	614.73
3	278	916.03	919.96	993.71	952.41	790.37	887.24	203.34
4	297	1,602.62	1,658.82	1,965.71	1,657.41	1,719.44	1,722.26	363.09
5	445	147.13	99.95	209.29	198.59	67.99	141.90	141.30
6	561	388.77	451.81	423.51	230.32	622.14	584.54	391.82
7	634	421.43	314.89	418.80	292.46	378.61	361.78	128.96
8	711	544.82	466.45	612.16	574.05	525.26	553.28	145.71
9	816	258.25	209.36	494.51	541.37	176.36	229.01	365.01
10	833	1,697.84	1,853.23	2,353.12	1,755.90	1,401.88	1,404.16	951.24
11	988	212.94	130.49	612.55	480.58	462.74	416.69	482.06
12	1,020	986.16	1,016.01	1,066.75	627.19	1,400.81	1,213.87	773.61
13	1,021	789.68	696.21	761.22	763.15	725.55	739.61	93.47
14	1,319	297.99	146.26	423.02	402.56	271.58	267.81	276.76
15	1,370	868.67	629.90	974.59	799.61	860.23	770.55	344.69
16	1,454	142.22	49.64	128.83	77.86	93.24	81.85	92.58
17	1,812	129.27	141.82	66.85	97.70	125.16	185.01	118.16
18	1,853	371.67	337.13	414.78	213.52	563.80	473.56	350.28
19	2,334	3,303.65	4,544.42	2,366.32	3,061.32	2,686.56	3,140.71	2,178.10
20	2,465	557.29	426.84	681.54	454.55	605.48	480.49	254.70
21	2,677	834.65	835.82	875.75	721.07	1,093.94	1,023.10	372.87
22	2,865	179.04	169.04	239.47	127.64	332.15	278.85	204.52
23	2,987	492.63	509.21	446.38	465.51	498.64	515.52	69.15
24	3,492	248.65	319.27	419.46	348.55	464.67	335.43	216.02
25	3,998	75.19	95.96	16.29	26.65	83.40	165.21	148.93
26	4,017	670.65	653.97	711.04	679.16	750.02	750.44	96.47
27	4,418	136.03	99.69	171.79	130.25	161.08	160.89	72.11
28	4,703	51.37	62.91	26.90	83.97	93.28	116.57	89.67
29	5,969	337.65	391.01	422.34	414.47	394.96	438.86	101.22
30	6,123	153.23	165.16	37.05	67.23	91.26	90.44	128.11
31	8,433	1,033.92	974.14	1,131.23	1,024.36	1,048.00	991.04	157.10
32	9,271	122.25	94.17	105.95	65.66	93.19	82.41	56.59
33	12,147	196.05	133.66	192.30	139.51	119.24	90.81	105.24
34	12,786	151.29	124.33	100.59	74.27	62.71	31.72	119.57
35	15,081	229.48	309.04	191.94	235.00	106.00	134.07	203.03
36	15,560	45.99	46.57	51.42	74.57	13.17	10.12	64.45
37	22,465	170.29	194.08	66.45	82.42	25.13	44.86	168.95
38	29,761	602.55	622.43	525.49	494.28	406.34	407.35	216.09

Largest impact spread for all models

Obs	Loops	Impact Per Loop in Dollars: Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Impact Spread (Max-Min)
1	20	2,750.83	7,066.06	3,567.85	4,514.33	0.00	0.00	7,066.06
2	96	4,285.02	3,785.22	6,006.50	2,739.33	1,919.90	0.00	6,006.50
3	2,334	3,303.65	4,544.42	2,366.32	3,061.32	2,686.56	3,140.71	2,178.10
4	151	0.00	328.18	244.24	1,598.28	0.00	0.00	1,598.28
5	258	0.00	1,276.71	0.00	269.94	0.00	0.00	1,276.71
6	4,797	0.00	969.62	0.00	866.73	0.00	954.09	969.62
7	833	1,697.84	1,853.23	2,353.12	1,755.90	1,401.88	1,404.16	951.24
8	167	2,884.42	3,347.12	3,422.18	3,749.64	2,802.40	3,326.11	947.23
9	1,020	986.16	1,016.01	1,066.75	627.19	1,400.81	1,213.87	773.61
10	163	0.00	190.61	669.77	0.00	0.00	0.00	669.77
11	217	1,422.84	1,342.81	1,635.07	1,410.01	1,282.53	1,020.33	614.73
12	5,637	0.00	535.46	0.00	40.05	0.00	380.74	535.46
13	988	212.94	130.49	612.55	480.58	462.74	416.69	482.06
14	561	388.77	451.81	423.51	230.32	622.14	584.54	391.82
15	2,677	834.65	835.82	875.75	721.07	1,093.94	1,023.10	372.87
16	816	258.25	209.36	494.51	541.37	176.36	229.01	365.01
17	297	1,602.62	1,658.82	1,965.71	1,657.41	1,719.44	1,722.26	363.09
18	1,853	371.67	337.13	414.78	213.52	563.80	473.56	350.28
19	1,370	868.67	629.90	974.59	799.61	860.23	770.55	344.69
20	1,319	297.99	146.26	423.02	402.56	271.58	267.81	276.76
21	2,465	557.29	426.84	681.54	454.55	605.48	480.49	254.70
22	2,333	81.62	157.96	8.32	0.00	237.91	250.66	250.66
23	1,921	100.04	175.02	36.54	0.00	197.10	229.84	229.84
24	29,761	602.55	622.43	525.49	494.28	406.34	407.35	216.09
25	3,492	248.65	319.27	419.46	348.55	464.67	335.43	216.02
26	7,064	0.00	187.16	0.00	209.49	0.00	77.39	209.49
27	2,865	179.04	169.04	239.47	127.64	332.15	278.85	204.52
28	278	916.03	919.96	993.71	952.41	790.37	887.24	203.34
29	15,081	229.48	309.04	191.94	235.00	106.00	134.07	203.03

Impact spread for selected models

	All Study Areas			Percent SARs Impacted			
	Count	Loops	Cost Per Loop	Model 1	Model 2	Model 5	Model 6
All Study Areas	726	3,504,525	$860	8.82%	9.50%	8.68%	9.23%
Groups By Line Count							
Less than 500	62	18,588	$2,046	11.3%	19.4%	9.7%	8.1%
501 - 750	60	38,429	$1,406	8.3%	5.0%	5.0%	6.7%
751 - 1000	44	39,433	$1,360	9.1%	9.1%	9.1%	9.1%
1001 - 1500	81	98,959	$1,333	7.4%	7.4%	8.6%	11.1%
1501 - 2000	59	102,817	$1,271	6.8%	6.8%	10.2%	8.5%
2001 - 3000	90	225,503	$1,105	8.9%	6.7%	11.1%	10.0%
3001 - 4000	70	244,042	$993	7.1%	5.7%	5.7%	5.7%
4001 - 5000	55	243,922	$954	7.3%	10.9%	7.3%	10.9%
5001 - 7500	81	501,841	$893	9.9%	11.1%	12.3%	12.3%
7501 - 15,000	84	890,949	$778	7.1%	8.3%	6.0%	7.1%
More than 15,000	40	1,100,042	$672	17.5%	20.0%	10.0%	12.5%
Groups By Density							
Less than 1.3	95	264,870	$1,333	6.3%	9.5%	5.3%	5.3%
1.3 - 3	105	449,629	$1,108	12.4%	13.3%	12.4%	14.3%
3 - 6	86	310,198	$1,002	10.5%	9.3%	15.1%	14.0%
6 - 10	90	229,461	$957	4.4%	3.3%	4.4%	4.4%
10 - 15	84	323,181	$833	14.3%	13.1%	13.1%	13.1%
15 - 25	110	617,635	$775	2.7%	3.6%	3.6%	3.6%
25 - 50	100	709,100	$700	11.0%	9.0%	7.0%	9.0%
More than 50	56	600,451	$645	10.7%	19.6%	10.7%	12.5%

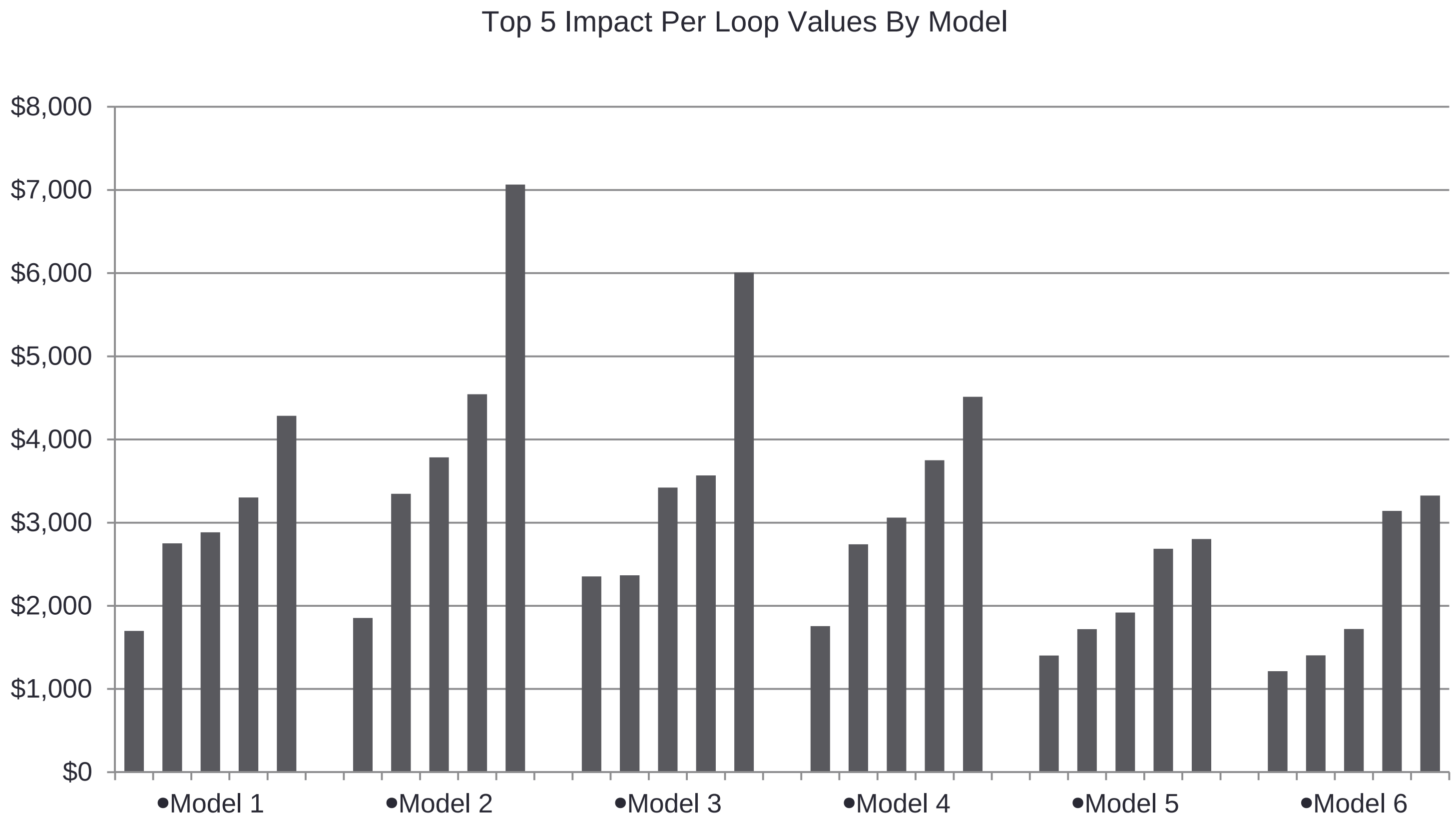
Impact spread for selected models

	All Study Areas			$ Total Impact (Cut Costs)			
	Count	Loops	Cost Per Loop	Model 1	Model 2	Model 5	Model 6
All Study Areas	726	3,504,525	$860	$81,636,603	$97,410,806	$63,269,803	$72,905,732
Groups By Line Count							
Less than 500	62	18,588	$2,046	$2,052,940	$2,572,306	$1,691,274	$1,598,184
501 - 750	60	38,429	$1,406	$906,847	$784,752	$962,518	$970,833
751 - 1000	44	39,433	$1,360	$1,850,780	$1,935,506	$1,781,311	$1,784,172
1001 - 1500	81	98,959	$1,333	$3,640,080	$2,944,461	$4,065,111	$3,865,900
1501 - 2000	59	102,817	$1,271	$1,130,487	$1,229,419	$1,770,437	$1,809,328
2001 - 3000	90	225,503	$1,105	$14,247,937	$16,270,148	$14,395,867	$14,779,150
3001 - 4000	70	244,042	$993	$1,775,662	$2,060,517	$2,784,721	$2,677,962
4001 - 5000	55	243,922	$954	$3,872,059	$8,517,941	$4,448,914	$9,277,850
5001 - 7500	81	501,841	$893	$4,130,443	$10,395,515	$4,490,165	$8,110,713
7501 - 15,000	84	890,949	$778	$14,738,401	$14,991,904	$12,418,298	$12,548,882
More than 15,000	40	1,100,042	$672	$33,290,967	$35,708,338	$14,461,186	$15,482,759
Groups By Density							
Less than 1.3	95	264,870	$1,333	$5,743,232	$13,483,126	$5,274,183	$11,696,637
1.3 - 3	105	449,629	$1,108	$16,456,229	$17,135,918	$19,372,773	$19,091,785
3 - 6	86	310,198	$1,002	$4,833,353	$4,531,674	$6,818,796	$6,263,359
6 - 10	90	229,461	$957	$1,194,176	$1,802,621	$1,368,037	$2,428,286
10 - 15	84	323,181	$833	$3,997,631	$3,763,117	$3,604,070	$3,808,371
15 - 25	110	617,635	$775	$3,314,240	$2,616,118	$2,466,979	$2,326,578
25 - 50	100	709,100	$700	$16,389,690	$15,044,064	$4,023,964	$4,587,576
More than 50	56	600,451	$645	$29,708,052	$39,034,168	$20,341,000	$22,703,140

Impact spread for selected models

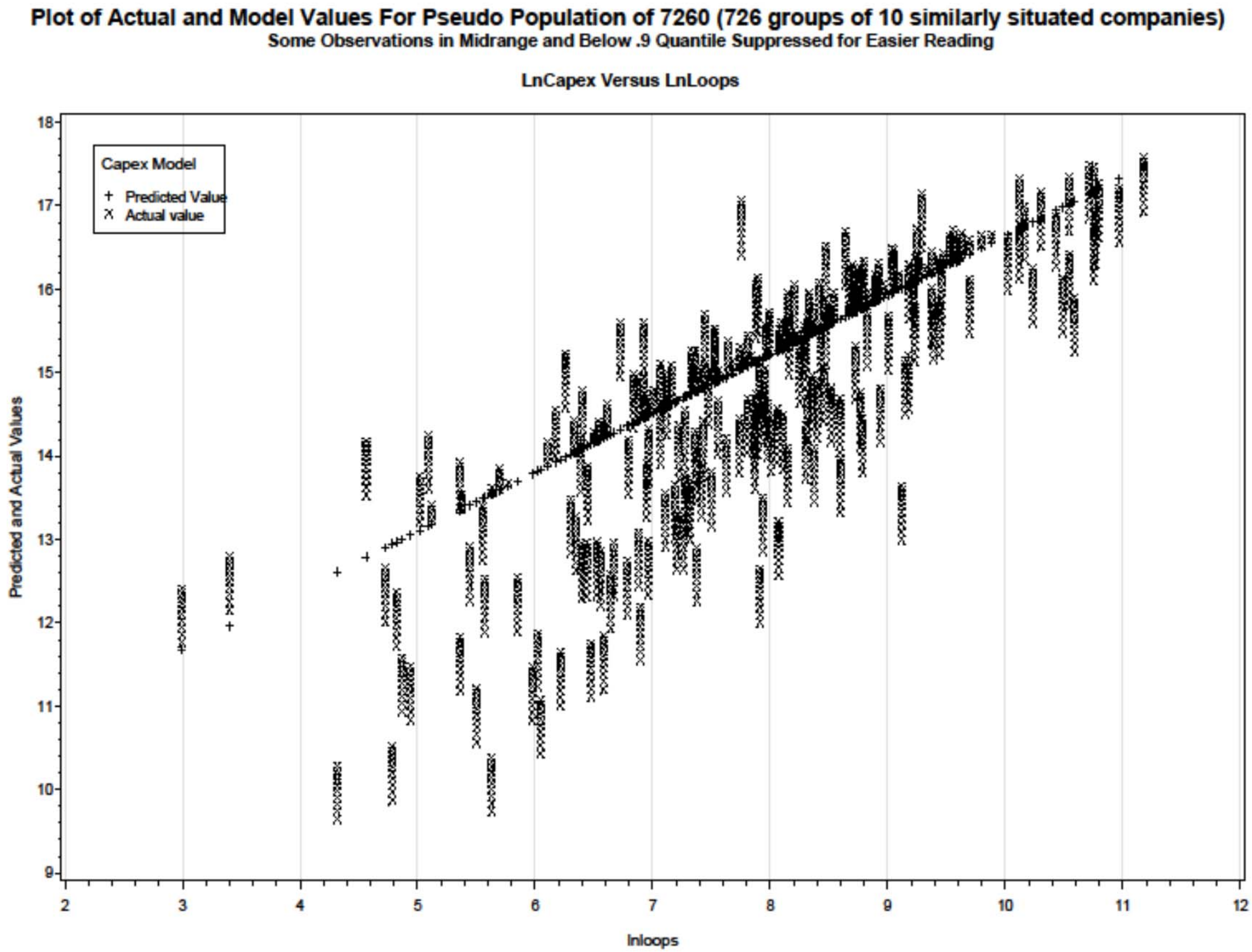
	All Study Areas			Impact Per Loop Impacted SARs				% Costs Cut For Impacted SARs			
	Count	Loops	Cost Per Loop	Model 1	Model 2	Model 5	Model 6	Model 1	Model 2	Model 5	Model 6
All Study Areas	726	3,504,525	$860	$246.71	$240	$228	$233	19.0%	19.3%	16.0%	16.2%
Groups By Line Count											
Less than 500	62	18,588	$2,046	$1,350.62	$924	$1,128	$1,138	28.4%	20.4%	24.5%	29.7%
501 - 750	60	38,429	$1,406	$292.63	$412	$505	$377	10.0%	17.0%	20.8%	17.4%
751 - 1000	44	39,433	$1,360	$542.11	$536	$522	$523	16.5%	17.1%	15.9%	15.9%
1001 - 1500	81	98,959	$1,333	$499.05	$409	$477	$353	21.5%	17.9%	21.3%	15.8%
1501 - 2000	59	102,817	$1,271	$153.70	$169	$166	$200	9.6%	11.9%	11.8%	13.8%
2001 - 3000	90	225,503	$1,105	$694.55	$1,039	$570	$648	24.5%	32.3%	22.4%	23.9%
3001 - 4000	70	244,042	$993	$103.29	$147	$199	$191	6.6%	8.7%	11.8%	11.3%
4001 - 5000	55	243,922	$954	$222.87	$314	$256	$342	18.9%	22.0%	21.8%	24.0%
5001 - 7500	81	501,841	$893	$83.63	$189	$73	$132	7.2%	13.6%	5.7%	8.9%
7501 - 15,000	84	890,949	$778	$249.10	$215	$245	$212	20.1%	16.6%	18.2%	15.1%
More than 15,000	40	1,100,042	$672	$230.26	$177	$175	$154	24.3%	21.2%	17.6%	16.8%
Groups By Density											
Less than 1.3	95	264,870	$1,333	$475.79	$667	$452	$594	21.1%	22.2%	19.6%	20.9%
1.3 - 3	105	449,629	$1,108	$609.20	$514	$699	$495	24.5%	22.5%	29.5%	22.2%
3 - 6	86	310,198	$1,002	$241.15	$337	$187	$203	12.4%	15.9%	10.5%	11.1%
6 - 10	90	229,461	$957	$84.00	$133	$86	$171	7.2%	11.5%	7.4%	14.5%
10 - 15	84	323,181	$833	$66.99	$74	$70	$74	7.6%	7.9%	7.5%	7.9%
15 - 25	110	617,635	$775	$201.52	$150	$137	$133	14.8%	10.9%	10.2%	9.6%
25 - 50	100	709,100	$700	$135.90	$154	$72	$61	14.1%	14.9%	6.9%	6.5%
More than 50	56	600,451	$645	$488.36	$244	$334	$345	33.6%	26.1%	23.0%	24.5%

Issue 3: Modeling Options (continued)



Issue 4: Simulation

- The concept of similarly situated carriers can be tested with a simulation using hypothetical perfectly similar situations
  - Carriers that are equal are by definition similar
  - Creation of 10 equal carriers with slight variation in cost
  - One of the 10 equal carriers is hypothetically inefficient (being above the 90^{th} percentile for the similar carriers)


Plot of Actual and Model Values For Pseudo Population of 7260 (726 groups of 10 similarly situated companies)
Some Observations in Midrange and Below .9 Quantile Suppressed for Easier Reading
LnCapex Versus LnLoops
Capex Model
+ Predicted Value
X Actual value
Predicted and Actual Values
18
17
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lnloops

Issue 4: Simulation (continued)

- When the model goodness of fit improves, the ability to compare peer carriers improves
  - Using all 726 study areas from the original FCC model and residuals from OLS regression to simulate model improvements.

Success of Current FCC Model in Identifying 90th Percenters from True Similar Situations
Similar Situations Formed by Replication

		Residual Adjustjment Divisor						
Factors by which variance around model was reduced	FCC Model	1.2	1.5	2	5	10	20	50
R Squared (from OLS fit)	0.879	0.9127	0.9423	0.9667	0.9945	0.9986	0.9997	0.9999
Benchmarked from groups with:								
90% Cost Mark-up	194	205	231	271	414	527	651	725
80% Cost Mark-up	155	166	181	201	224	178	66	0
70% Cost Mark-up	116	121	123	119	62	11	0	0
60% Cost Mark-up	85	87	79	67	16	1	0	0
50% Cost Mark-up	61	56	46	33	3	0	0	0
40% Cost Mark-up	42	33	30	17	0	0	0	0
30% Cost Mark-up	29	25	17	8	0	0	0	0
20% Cost Mark-up	21	14	8	2	0	0	0	0
10% Cost Mark-up	11	8	3	1	0	0	0	0
NO Cost Mark-up (Original Costs)	6	3	2	0	0	0	0	0
90% Cost Mark-up Hits of Total Hits	26.72%	28.24%	31.82%	37.33%	57.02%	72.59%	89.67%	99.86%

Issue 4: Simulation (continued)

- Using 662 study areas from the original FCC model not affected by 90th percentile benchmarks for replication and residuals from quantile regression to simulate model improvements

Success of Current FCC QRA Model in Identifying 90th Percenters from True Similar Situations
Models Applied to Groups of 10 Formed from 662 Study Areas Originally Identified as Efficient
(Total Observations in Each Model: 6620)

		Residual Adjustjment Divisor						
Factors by which variance around model was reduced	FCC Model	1.2	1.5	2	5	10	20	50
Pseudo R Squared From QRA Model	0.675	0.706	0.734	0.762	0.802	0.809	0.811	0.817
Pseudo R Squared Recalculated for Cost Per Loop	0.434	0.481	0.530	0.581	0.658	0.672	0.678	0.691
Benchmarked from groups with:								
90% Cost Mark-up	218	234	257	292	429	540	635	662
80% Cost Mark-up	172	183	194	203	198	113	18	0
70% Cost Mark-up	128	128	122	110	25	0	0	0
60% Cost Mark-up	78	68	62	38	0	0	0	0
50% Cost Mark-up	39	30	15	8	0	0	0	0
40% Cost Mark-up	14	9	4	1	0	0	0	0
30% Cost Mark-up	3	2	0	0	0	0	0	0
20% Cost Mark-up	1	0	0	0	0	0	0	0
10% Cost Mark-up	0	0	0	0	0	0	0	0
NO Cost Mark-up (Original Costs)	0	0	0	0	0	0	0	0
90% Cost Mark-up Hits of Total Hits	32.93%	35.35%	38.82%	44.11%	64.80%	81.57%	95.92%	100.00%

Issue 4: Simulation (continued)

- The simulation demonstrates the error in supposing that if there were 100 carriers with identical independent values, 10 of them would be impacted by QRA
  - Only 26 percent of the simulated high-cost carriers were correctly identified in the original FCC model
  - Only 33 percent of the simulated high-cost carriers were correctly identified when model was applied to study areas not affected by original model benchmarks
  - An accurate model is critical to any analysis used to impact a carrier

QUESTIONS / DISCUSSION

Thank You

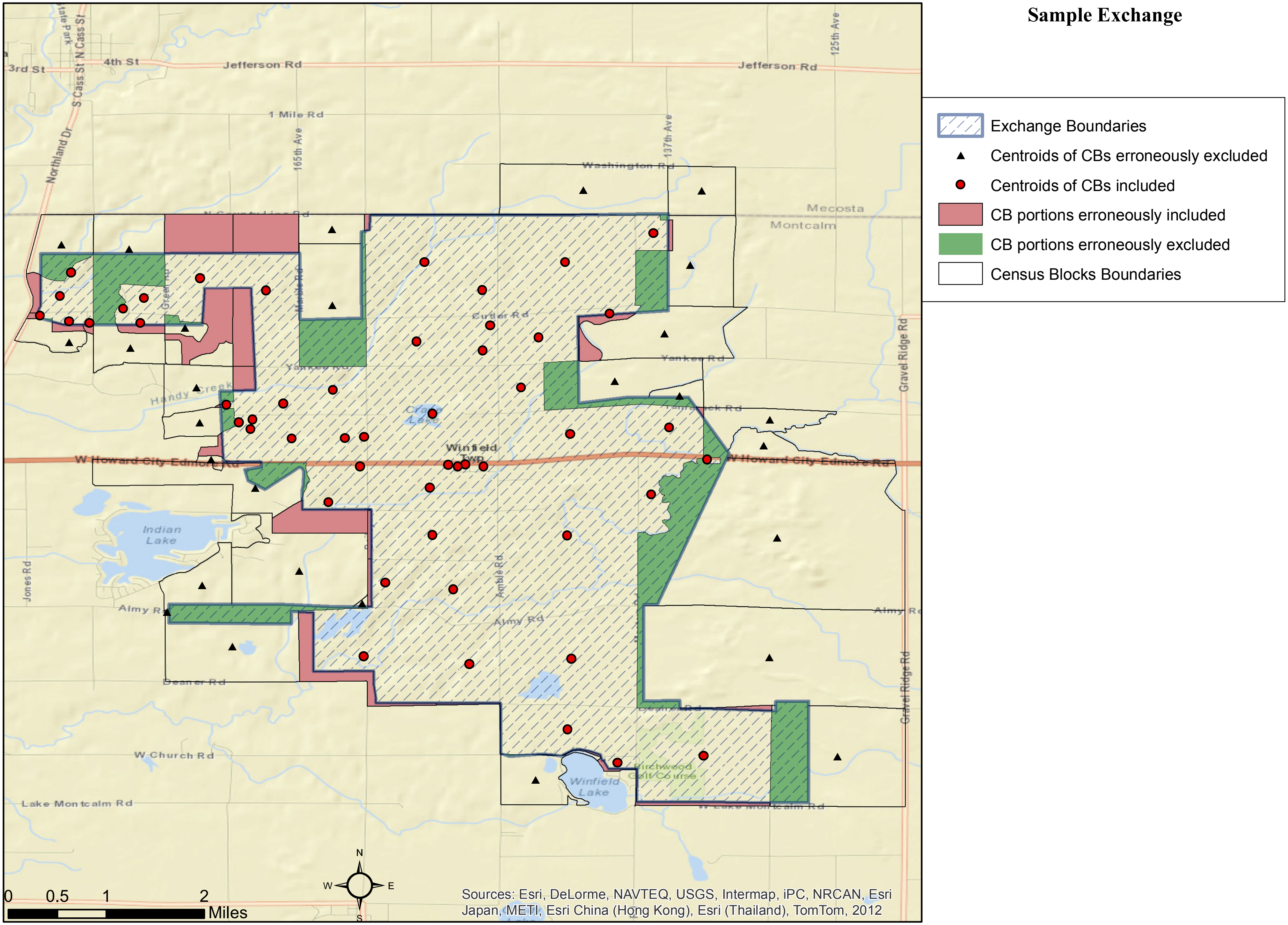
Quantile Regression

Issues Meeting, May 29, 2013

Ex Parte

Appendix

Sample Exchange



Census Blocks Associated with Upper Peninsula Study Area

	CBs Inside or on Study Area Boundaries		CBs Included in Study Area By Centroid Method	
	All	Populated	All	Populated
Number of Census Blocks	3,699	1,463	2,922	1,125
Area in Square Miles	3,286.41	2,281.59	2,072.81	1,460.27
Area Overlapping with Study Area	2,101.13	1,489.89	2,022.13	1,417.48
Housing Units	14,382	14,382	10,333	10,333
Number of CBs Designated As:				
Urban	27	23	23	20
Tribal	2	1	2	1
Parkland	0	0	0	0

Size and Density Distribution of Populated Census Blocks

Variable	Minimum	Maximum	Average	Standard Deviation
Housing Units	1	175	10	15
Area in Square Miles	0.0003	35.7009	1.5595	3.2226
Density	0.06	7,714.18	122.78	359.08

Count of Populated CBs with Missassigned Areas By Portion of Missassignment Based on Square Miles

Portion Of CB Area Missasigned	CBs With Area Erronoeusly :		Total CBs with Missassigned Areas	Missassigned CBs as % of All Populated CBs
	Included	Excluded		
More than 2 %	122	141	263	17.98%
More than 5 %	98	108	206	14.08%
More than 10 %	66	87	153	10.46%
More than 20 %	44	58	102	6.97%
More than 50 %	7	8	15	1.03%

Household Density Profile of Populated CBs with Missassigned Portions of More than 5 %

	Included CBs			Excluded CBs		
	Housing Units	Area	Density	Housing Units	Area	Density
Minimum	1	0.0030	0.1960	1	0.0012	0.1080
Maximum	49	21.6512	663.7890	94	24.3573	856.1870
Average	11	1.7162	71.2450	13	2.1412	91.5880
Standard Deviation	12	3.2956	138.6230	16	4.1712	185.1520

Profile of CBs With Missassigned Portions of More than 5 %

	Included	Excluded
Number of Census Blocks	98	108
Area in Square Miles	168.19	231.25
Area Overlapping with Study Area	127.21	69.54
Housing Units	1080	1,359
Number of CBs Designated As:		
Urban	0	2
Tribal	0	0
Parkland	0	0
Estimated Missassigned Housing Units		
Maximum	1080	1359
Minimum	0	0
In Proportion to Area Misses	268	350

Effect of Housing Units Missassignment on Density and Model Results for Different Scenarios

	Net Effect of Missassigned Portions On HU	Corrected Count HU	Corrected Density	% Change Density
Scenario (Excl-Incl)				
Min-Min	0	10,333	4.917828	0.00%
Min- Max	-1080	9,253	4.403820	-10.45%
Max- Min	1359	11,692	5.564623	13.15%
Max - Max	279	10,612	5.050614	2.70%
Proportional Method	82	10,415	4.956665	0.79%

Household Density Profile of Populated CBs with Missassigned Portions of More than 10 %

	Included CBs			Excluded CBs		
	Housing Units	Area	Density	Housing Units	Area	Density
Minimum	1	0.0030	0.1960	1	0.0012	0.1080
Maximum	49	21.6512	663.7890	94	24.3573	856.1870
Average	13	1.8715	70.9580	13	2.3705	88.4540
Standard Deviation	13	3.4037	138.8380	15	4.4925	177.4290

Profile of CBs With Missassigned Portions of More than 10 %

	Included	Excluded
Number of Census Blocks	66	87
Area in Square Miles	123.52	206.24
Area Overlapping with Study Area	85.99	67.81
Housing Units	847	1,096
Number of CBs Designated As:		
Urban	0	0
Tribal	0	0
Parkland	0	0
Estimated Missassigned Housing Units		
Maximum	847	1096
Minimum	0	0
In Proportion to Area Misses	251	333

Effect of Housing Units Missassignment on Density and Model Results for Different Scenarios

	Net Effect of Missassigned Portions On HU	Corrected Count HU	Corrected Density	% Change Density
Scenario (Excl-Incl)				
Min-Min	0	10,333	4.917828	0.00%
Min- Max	-847	9,486	4.514712	-8.20%
Max- Min	1096	11,429	5.439452	10.61%
Max - Max	249	10,582	5.036336	2.41%
Proportional Method	83	10,416	4.957244	0.80%

Total Cost Model Coefficients Over Years

Same form and structure as FCC's Capex and Opex Models

Variable	2006	2007	2008	2009	2010	2011	2012
lnloops	0.760	0.710	0.740	0.805	0.741	0.676	0.644
lnroadmiles	-0.303	-0.305	-0.318	-0.350	-0.350	-0.217	-0.235
lnroadcrossin	0.295	0.327	0.315	0.312	0.366	0.242	0.246
lnstatesacs	-0.041	-0.037	-0.066	-0.051	-0.077	-0.076	-0.102
pctundepplant	0.014	0.016	0.015	0.016	0.017	0.018	0.007
lndensity	-0.191	-0.170	-0.197	-0.246	-0.211	-0.140	-0.147
lnexchanges	0.092	0.109	0.106	0.077	0.101	0.136	0.104
pctbedrock36	0.083	-0.052	0.169	0.034	-0.012	0.185	0.091
diff	0.173	0.262	0.201	0.183	0.122	0.136	0.112
climate	0.135	0.125	0.141	0.136	0.113	0.112	0.121
pcttriballand	0.002	0.002	0.002	0.001	0.001	0.002	0.002
pctparkland	0.007	0.007	0.009	0.010	0.010	0.011	0.007
pcturban	-0.001	0.000	0.001	0.000	0.002	0.002	0.003
alaska	-0.031	0.095	0.091	-0.219	-0.114	-0.033	0.258
midwest	0.170	0.142	0.146	0.134	0.121	0.115	0.130
northeast	0.062	0.042	0.053	-0.020	-0.049	-0.117	0.008
Intercept	7.168	7.267	7.304	7.254	7.512	7.929	8.211

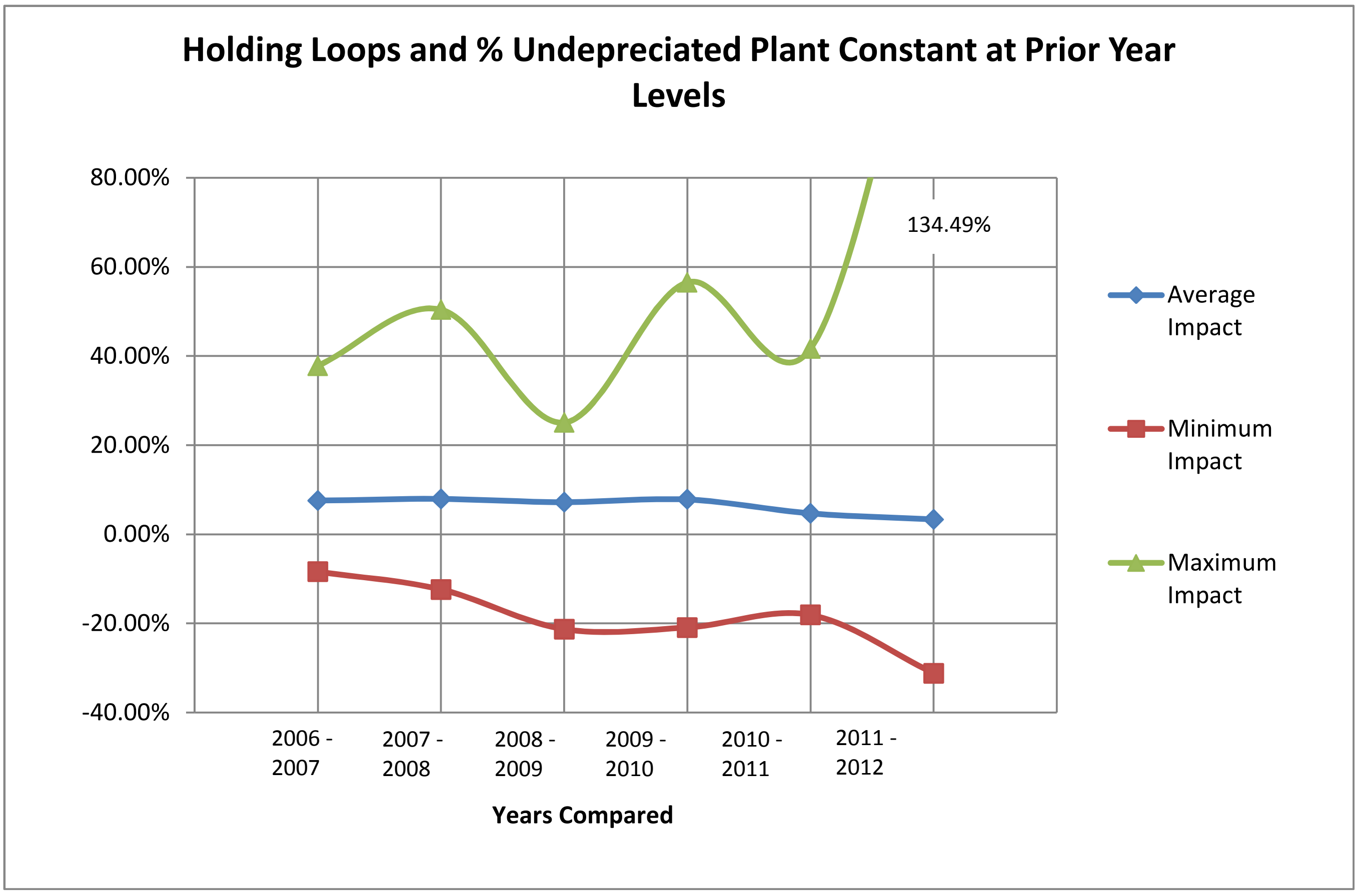
Shaded gray are variables that were not statistically significant at 90% level

Year to Year Impact of Model Coefficients Updates on Study Areas' Benchmarks

Total Cost Model - FCC Variables and Structure

Holding Loops and % Undepreciated Plant Constant at Prior Year Levels

Number of Study Areas	Years Compared	% CHANGE IN TOTCOST BENCHMARKs Average Impact	Minimum Impact	Maximum Impact	Standard Deviation
659	2006 - 2007	7.56%	-8.40%	37.79%	4.45%
678	2007 - 2008	7.93%	-12.37%	50.40%	7.18%
692	2008 - 2009	7.20%	-21.28%	25.06%	5.14%
707	2009 - 2010	7.80%	-20.91%	56.52%	5.80%
722	2010 - 2011	4.69%	-18.10%	41.67%	6.98%
724	2011 - 2012	3.32%	-31.17%	134.49%	9.18%

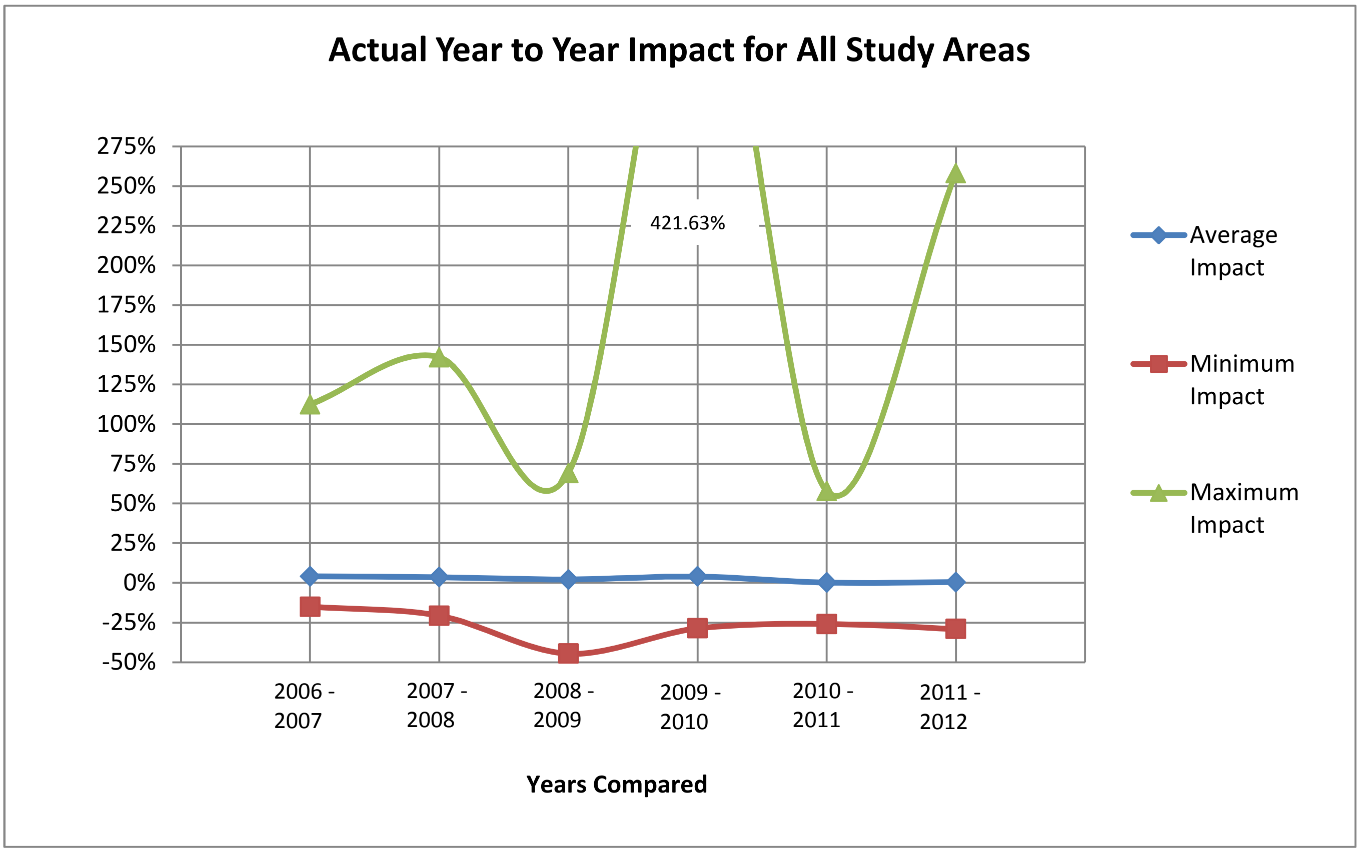


Year to Year Impact of Model Coefficients Updates on Study Areas' Benchmarks

Total Cost Model - FCC Variables and Structure

Actual Year to Year Impact for All Study Areas

		% CHANGE IN TOTCOST BENCHMARKS			
Number of Study Areas	Years Compared	Average Impact	Minimum Impact	Maximum Impact	Standard Deviation
659	2006 - 2007	4.12%	-15.05%	112.43%	10.96%
678	2007 - 2008	3.56%	-20.72%	142.11%	13.02%
692	2008 - 2009	2.10%	-44.57%	69.13%	11.31%
707	2009 - 2010	4.00%	-28.68%	421.63%	24.34%
722	2010 - 2011	0.17%	-25.94%	57.83%	10.89%
724	2011 - 2012	0.41%	-29.10%	258.08%	14.57%

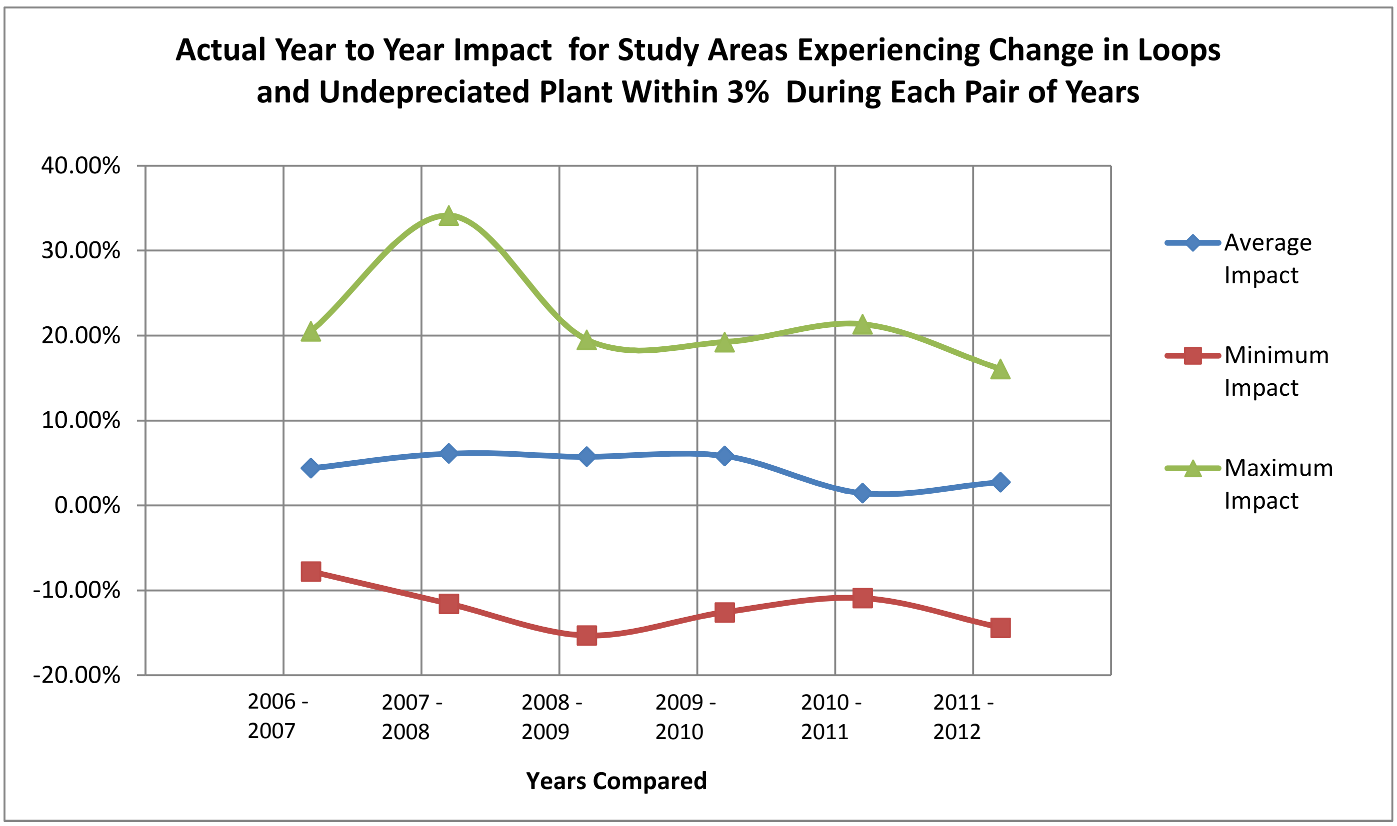


Year to Year Impact of Model Coefficients Updates on Study Areas' Benchmarks

Total Cost Model - FCC Variables and Structure

Actual Year to Year Impact for Study Areas Experiencing Change in Loops and Undepreciated Plant Within 3% During Each Pair of Years

		% CHANGE IN TOTCOST BENCHMARK			
Number of Study Areas	Years Compared	Average Impact	Minimum Impact	Maximum Impact	Std Dev
225	2006 - 2007	4.38%	-7.78%	20.51%	5.04%
166	2007 - 2008	6.11%	-11.58%	34.13%	7.96%
106	2008 - 2009	5.73%	-15.32%	19.51%	6.78%
81	2009 - 2010	5.82%	-12.58%	19.23%	7.02%
116	2010 - 2011	1.44%	-10.91%	21.34%	6.38%
113	2011 - 2012	2.75%	-14.39%	16.05%	6.01%



Parameter coefficients for different versions of Total Cost QRA Model. Highlighted in gray are variables which are not statistically significant.

Parameter	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	7.9295	7.6521	8.0557	7.8984	9.4453	9.0761
lnloops	0.6761	0.747	0.7054	0.7335	0.2813	0.3383
pctundepplant	0.018	0.0174	0.0181	0.019	0.0162	0.0172
lnexchanges	0.1359	0.0912	0.1307	0.1041	0.1021	0.0794
lnroadmiles	-0.2167	-0.3373			-0.2506	-0.2121
lnroadcrossings	0.2425	0.3375			0.2481	0.2311
lnstatesacs	-0.0761	-0.0891	-0.0854	-0.0809	-0.0952	-0.0895
lndensity	-0.1396	-0.2043	-0.0843	-0.1403	-0.1929	-0.2135
pctbedrock36	0.1855		0.2743		0.287	
diff	0.136		0.1208		0.1036	
climate	0.1124	0.1283	0.1232	0.1548	0.1216	0.1409
pcttriballandland	0.0016	0.0019	0.0014	0.0016	0.0015	0.0025
pctparkland	0.0105		0.008		0.0137	
pcturban	0.0019		0.0024	0.0028	0.0004	
alaska	-0.0329		0.0858		-0.2137	
midwest	0.1146	0.1681	0.1268	0.1446	0.1799	0.1997
northeast	-0.1166		-0.1113		-0.0503	
lndensity_sq					0.0231	0.0277
lnloops_sq					0.0589	0.0529
pseudoR2 log Model	0.689	0.690	0.687	0.674	0.692	0.693
pseudoR2 Recalculated for level costs	0.726	0.723	0.726	0.702	0.698	0.693
pseudoR2 Recalculated for cost per loop	0.450	0.456	0.458	0.412	0.465	0.470

Model 1 = FCC Model with 16 variables.
Model 2 = Model 1 minus insignificant variables
Model 3 = Model 1 minus two road variables
Model 4 = Model 2 minus two road variables
Model 5 = Model 1 plus squared terms for lnloops and lndensity
Model 6 = Model 2 plus squared terms for lnloops and lndensity

Comparison Of Four Different Model Selections With Respect to Impact on Costs, By Loop and Density Size

	All Study Areas			Percent SARs Impacted				$ Total Impact (Cut Costs)				Impact Per Loop Impacted SARs				% Costs Cut For Impacted SARs			
	Count	Loops	Cost Per Loop	Model 1	Model 2	Model 5	Model 6	Model 1	Model 2	Model 5	Model 6	Model 1	Model 2	Model 5	Model 6	Model 1	Model 2	Model 5	Model 6
All Study Areas	726	3,504,525	$860	8.82%	9.50%	8.68%	9.23%	$81,636,603	$97,410,806	$63,269,803	$72,905,732	$246.71	$240	$228	$233	19.0%	19.3%	16.0%	16.2%
<u>Groups By Line Count</u>																			
Less than 500	62	18,588	$2,046	11.3%	19.4%	9.7%	8.1%	$2,052,940	$2,572,306	$1,691,274	$1,598,184	$1,350.62	$924	$1,128	$1,138	28.4%	20.4%	24.5%	29.7%
501 - 750	60	38,429	$1,406	8.3%	5.0%	5.0%	6.7%	$906,847	$784,752	$962,518	$970,833	$292.63	$412	$505	$377	10.0%	17.0%	20.8%	17.4%
751 - 1000	44	39,433	$1,360	9.1%	9.1%	9.1%	9.1%	$1,850,780	$1,935,506	$1,781,311	$1,784,172	$542.11	$536	$522	$523	16.5%	17.1%	15.9%	15.9%
1001 - 1500	81	98,959	$1,333	7.4%	7.4%	8.6%	11.1%	$3,640,080	$2,944,461	$4,065,111	$3,865,900	$499.05	$409	$477	$353	21.5%	17.9%	21.3%	15.8%
1501 - 2000	59	102,817	$1,271	6.8%	6.8%	10.2%	8.5%	$1,130,487	$1,229,419	$1,770,437	$1,809,328	$153.70	$169	$166	$200	9.6%	11.9%	11.8%	13.8%
2001 - 3000	90	225,503	$1,105	8.9%	6.7%	11.1%	10.0%	$14,247,937	$16,270,148	$14,395,867	$14,779,150	$694.55	$1,039	$570	$648	24.5%	32.3%	22.4%	23.9%
3001 - 4000	70	244,042	$993	7.1%	5.7%	5.7%	5.7%	$1,775,662	$2,060,517	$2,784,721	$2,677,962	$103.29	$147	$199	$191	6.6%	8.7%	11.8%	11.3%
4001 - 5000	55	243,922	$954	7.3%	10.9%	7.3%	10.9%	$3,872,059	$8,517,941	$4,448,914	$9,277,850	$222.87	$314	$256	$342	18.9%	22.0%	21.8%	24.0%
5001 - 7500	81	501,841	$893	9.9%	11.1%	12.3%	12.3%	$4,130,443	$10,395,515	$4,490,165	$8,110,713	$83.63	$189	$73	$132	7.2%	13.6%	5.7%	8.9%
7501 - 15,000	84	890,949	$778	7.1%	8.3%	6.0%	7.1%	$14,738,401	$14,991,904	$12,418,298	$12,548,882	$249.10	$215	$245	$212	20.1%	16.6%	18.2%	15.1%
More than 15,000	40	1,100,042	$672	17.5%	20.0%	10.0%	12.5%	$33,290,967	$35,708,338	$14,461,186	$15,482,759	$230.26	$177	$175	$154	24.3%	21.2%	17.6%	16.8%
<u>Groups By Density</u>																			
Less than 1.3	95	264,870	$1,333	6.3%	9.5%	5.3%	5.3%	$5,743,232	$13,483,126	$5,274,183	$11,696,637	$475.79	$667	$452	$594	21.1%	22.2%	19.6%	20.9%
1.3 - 3	105	449,629	$1,108	12.4%	13.3%	12.4%	14.3%	$16,456,229	$17,135,918	$19,372,773	$19,091,785	$609.20	$514	$699	$495	24.5%	22.5%	29.5%	22.2%
3 - 6	86	310,198	$1,002	10.5%	9.3%	15.1%	14.0%	$4,833,353	$4,531,674	$6,818,796	$6,263,359	$241.15	$337	$187	$203	12.4%	15.9%	10.5%	11.1%
6 - 10	90	229,461	$957	4.4%	3.3%	4.4%	4.4%	$1,194,176	$1,802,621	$1,368,037	$2,428,286	$84.00	$133	$86	$171	7.2%	11.5%	7.4%	14.5%
10 - 15	84	323,181	$833	14.3%	13.1%	13.1%	13.1%	$3,997,631	$3,763,117	$3,604,070	$3,808,371	$66.99	$74	$70	$74	7.6%	7.9%	7.5%	7.9%
15 - 25	110	617,635	$775	2.7%	3.6%	3.6%	3.6%	$3,314,240	$2,616,118	$2,466,979	$2,326,578	$201.52	$150	$137	$133	14.8%	10.9%	10.2%	9.6%
25 - 50	100	709,100	$700	11.0%	9.0%	7.0%	9.0%	$16,389,690	$15,044,064	$4,023,964	$4,587,576	$135.90	$154	$72	$61	14.1%	14.9%	6.9%	6.5%
More than 50	56	600,451	$645	10.7%	19.6%	10.7%	12.5%	$29,708,052	$39,034,168	$20,341,000	$22,703,140	$488.36	$244	$334	$345	33.6%	26.1%	23.0%	24.5%

Comparison of Different Models With Respect to Numbers of Impacted Study Areas

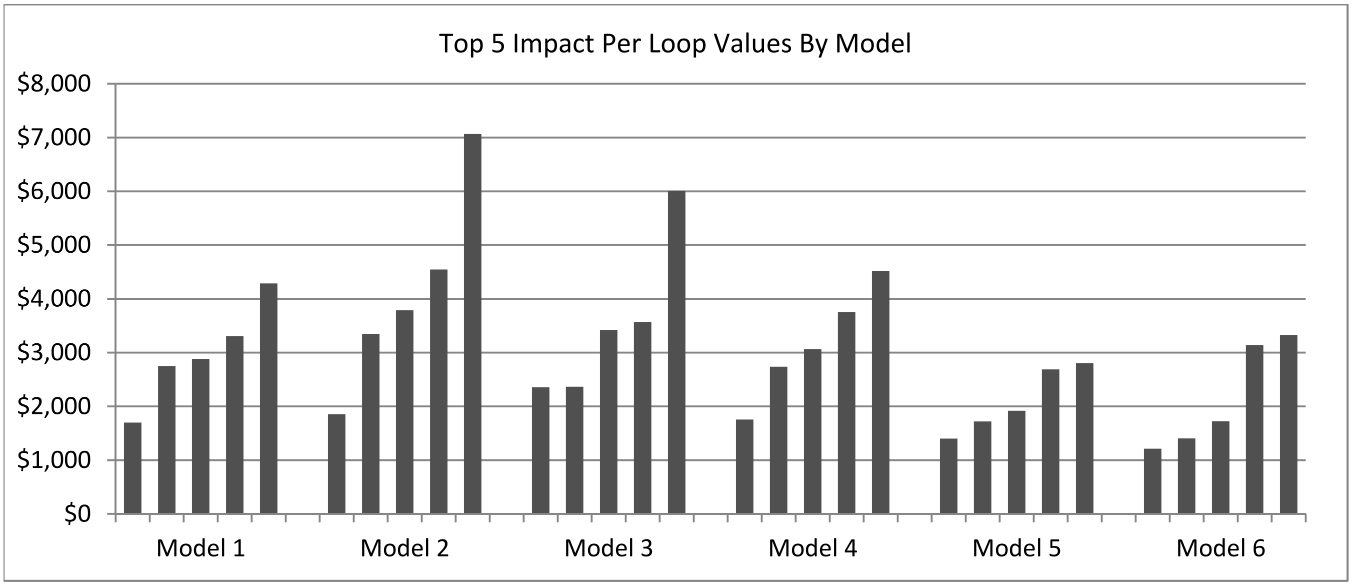
Count Of Study Areas Impacted Under Different Models

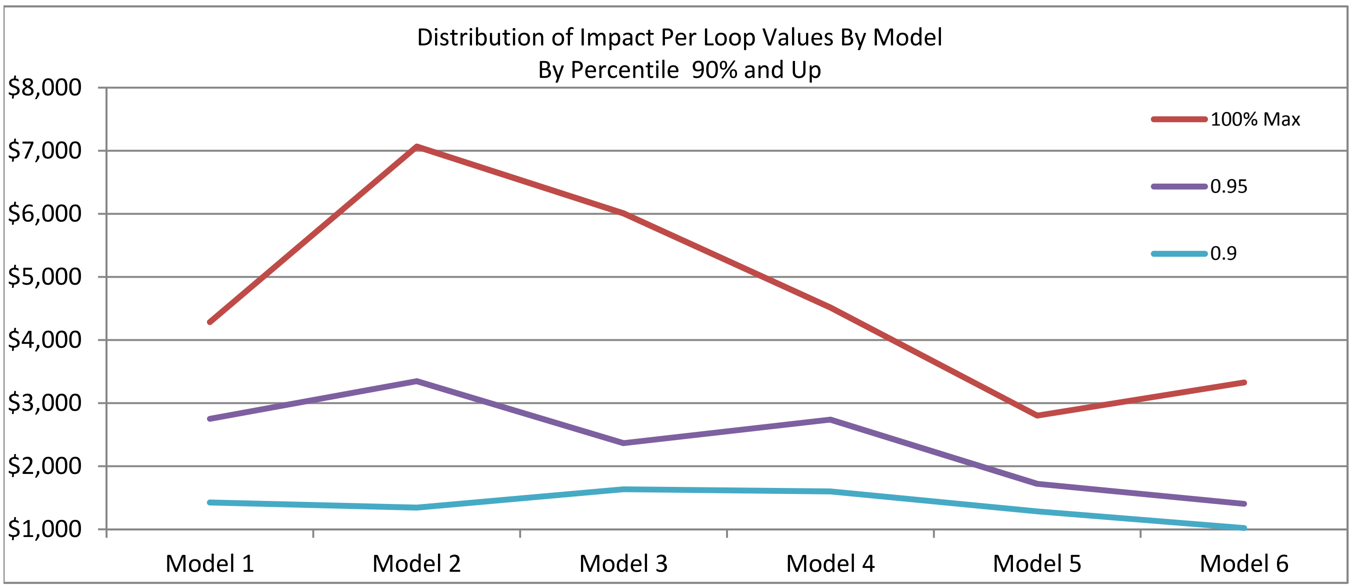
Number of Times Impacted	Impacted Study Areas
Never	628
Just Once	15
Twice	13
Three times	14
Four times	7
Five times	11
Always (six times)	38
At least once	98

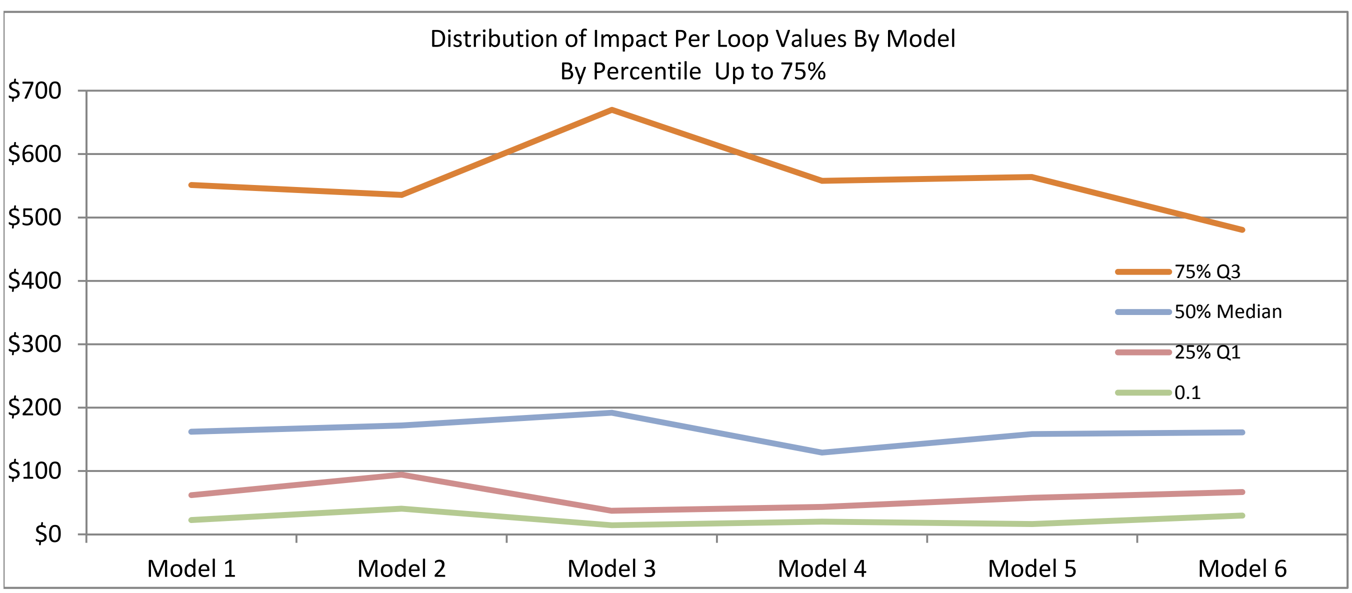
Study Areas Who Fare Better Under Alternative Models Compared to Model 1 (FCC Model)

Better Under:	Count of Study Areas
One Model or more	58
Two Models Or more	44
Three Models Or more	28
Four Models	14

Distribution of Impact Per Loop Values By Model







Impact Per Loop Under Total Cost QRA Alternative Models
For Study Areas With Largest Spread

		Impact Per Loop in Dollars						Impact Spread
Obs	**Loops**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**(Max-Min)**
1	29,761	602.55	622.43	525.49	494.28	406.34	407.35	216.09
2	278	916.03	919.96	993.71	952.41	790.37	887.24	203.34
3	15,081	229.48	309.04	191.94	235.00	106.00	134.07	203.03
4	163	0.00	190.61	669.77	0.00	0.00	0.00	669.77
5	1,921	100.04	175.02	36.54	0.00	197.10	229.84	229.84
6	2,677	834.65	835.82	875.75	721.07	1,093.94	1,023.10	372.87
7	1,370	868.67	629.90	974.59	799.61	860.23	770.55	344.69
8	1,853	371.67	337.13	414.78	213.52	563.80	473.56	350.28
9	1,319	297.99	146.26	423.02	402.56	271.58	267.81	276.76
10	2,465	557.29	426.84	681.54	454.55	605.48	480.49	254.70
11	2,865	179.04	169.04	239.47	127.64	332.15	278.85	204.52
12	297	1,602.62	1,658.82	1,965.71	1,657.41	1,719.44	1,722.26	363.09
13	3,492	248.65	319.27	419.46	348.55	464.67	335.43	216.02
14	7,064	0.00	187.16	0.00	209.49	0.00	77.39	209.49
15	217	1,422.84	1,342.81	1,635.07	1,410.01	1,282.53	1,020.33	614.73
16	5,637	0.00	535.46	0.00	40.05	0.00	380.74	535.46
17	833	1,697.84	1,853.23	2,353.12	1,755.90	1,401.88	1,404.16	951.24
18	96	4,285.02	3,785.22	6,006.50	2,739.33	1,919.90	0.00	6,006.50
19	816	258.25	209.36	494.51	541.37	176.36	229.01	365.01
20	988	212.94	130.49	612.55	480.58	462.74	416.69	482.06
21	561	388.77	451.81	423.51	230.32	622.14	584.54	391.82
22	167	2,884.42	3,347.12	3,422.18	3,749.64	2,802.40	3,326.11	947.23
23	2,333	81.62	157.96	8.32	0.00	237.91	250.66	250.66
24	20	2,750.83	7,066.06	3,567.85	4,514.33	0.00	0.00	7,066.06
25	1,020	986.16	1,016.01	1,066.75	627.19	1,400.81	1,213.87	773.61
26	151	0.00	328.18	244.24	1,598.28	0.00	0.00	1,598.28
27	4,797	0.00	969.62	0.00	866.73	0.00	954.09	969.62
28	258	0.00	1,276.71	0.00	269.94	0.00	0.00	1,276.71
29	2,334	3,303.65	4,544.42	2,366.32	3,061.32	2,686.56	3,140.71	2,178.10

Impact Per Loop Under Total Cost QRA Alternative Models
For Study Areas With Consistent Variation

		Impact Per Loop in Dollars						Impact Spread
Obs	Loops	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	(Max-Min)
1	1,812	129.27	141.82	66.85	97.70	125.16	185.01	118.16
2	1,454	142.22	49.64	128.83	77.86	93.24	81.85	92.58
3	9,271	122.25	94.17	105.95	65.66	93.19	82.41	56.59
4	12,786	151.29	124.33	100.59	74.27	62.71	31.72	119.57
5	2,987	492.63	509.21	446.38	465.51	498.64	515.52	69.15
6	29,761	602.55	622.43	525.49	494.28	406.34	407.35	216.09
7	278	916.03	919.96	993.71	952.41	790.37	887.24	203.34
8	15,081	229.48	309.04	191.94	235.00	106.00	134.07	203.03
9	22,465	170.29	194.08	66.45	82.42	25.13	44.86	168.95
10	6,123	153.23	165.16	37.05	67.23	91.26	90.44	128.11
11	4,703	51.37	62.91	26.90	83.97	93.28	116.57	89.67
12	1,021	789.68	696.21	761.22	763.15	725.55	739.61	93.47
13	15,560	45.99	46.57	51.42	74.57	13.17	10.12	64.45
14	445	147.13	99.95	209.29	198.59	67.99	141.90	141.30
15	634	421.43	314.89	418.80	292.46	378.61	361.78	128.96
16	4,418	136.03	99.69	171.79	130.25	161.08	160.89	72.11
17	2,677	834.65	835.82	875.75	721.07	1,093.94	1,023.10	372.87
18	1,370	868.67	629.90	974.59	799.61	860.23	770.55	344.69
19	1,853	371.67	337.13	414.78	213.52	563.80	473.56	350.28
20	1,319	297.99	146.26	423.02	402.56	271.58	267.81	276.76
21	8,433	1,033.92	974.14	1,131.23	1,024.36	1,048.00	991.04	157.10
22	2,465	557.29	426.84	681.54	454.55	605.48	480.49	254.70
23	711	544.82	466.45	612.16	574.05	525.26	553.28	145.71
24	3,998	75.19	95.96	16.29	26.65	83.40	165.21	148.93
25	2,865	179.04	169.04	239.47	127.64	332.15	278.85	204.52
26	297	1,602.62	1,658.82	1,965.71	1,657.41	1,719.44	1,722.26	363.09
27	3,492	248.65	319.27	419.46	348.55	464.67	335.43	216.02
28	217	1,422.84	1,342.81	1,635.07	1,410.01	1,282.53	1,020.33	614.73
29	833	1,697.84	1,853.23	2,353.12	1,755.90	1,401.88	1,404.16	951.24
30	12,147	196.05	133.66	192.30	139.51	119.24	90.81	105.24
31	816	258.25	209.36	494.51	541.37	176.36	229.01	365.01
32	988	212.94	130.49	612.55	480.58	462.74	416.69	482.06
33	561	388.77	451.81	423.51	230.32	622.14	584.54	391.82
34	167	2,884.42	3,347.12	3,422.18	3,749.64	2,802.40	3,326.11	947.23
35	4,017	670.65	653.97	711.04	679.16	750.02	750.44	96.47
36	5,969	337.65	391.01	422.34	414.47	394.96	438.86	101.22
37	1,020	986.16	1,016.01	1,066.75	627.19	1,400.81	1,213.87	773.61
38	2,334	3,303.65	4,544.42	2,366.32	3,061.32	2,686.56	3,140.71	2,178.10

Total Cost Model Coefficients Over Years
Model 6

Variable	2006	2007	2008	2009	2010	2011	2012
lnloops	0.2317	0.3699	0.4675	0.4510	0.3883	0.3383	0.2068
pctundepplant	0.0143	0.0143	0.0159	0.0171	0.0159	0.0172	0.0166
lnexchanges	0.0989	0.0956	0.1091	0.0745	0.0729	0.0794	0.0491
lnroadmiles	-0.2408	-0.2494	-0.2200	-0.3730	-0.3502	-0.2121	-0.0651
lnroadcrossin	0.2222	0.2467	0.2381	0.3523	0.3508	0.2311	0.1628
lnstatesacs	-0.0395	-0.0337	-0.0512	-0.0486	-0.0757	-0.0895	-0.1200
lndensity	-0.1977	-0.1930	-0.1975	-0.2795	-0.2527	-0.2135	-0.1767
climate	0.1351	0.1334	0.1450	0.1453	0.1287	0.1409	0.1207
pcttriballand	0.0026	0.0027	0.0025	0.0018	0.0019	0.0025	0.0020
midwest	0.1405	0.1412	0.1573	0.1563	0.1577	0.1997	0.2105
lnloops_sq	0.0669	0.0461	0.0326	0.0440	0.0489	0.0529	0.0645
lndensity_sq	-0.0033	0.0025	0.0136	0.0187	0.0178	0.0277	0.0355
Intercept	9.5864	9.0727	8.5150	8.5986	8.9740	9.0761	9.4818

Shaded gray are variables that were not statistically significant at 10% level or less.

lnloops_sq = lnloops*lnloops*0.5
lndensity = lndensity*lndensity*0.5

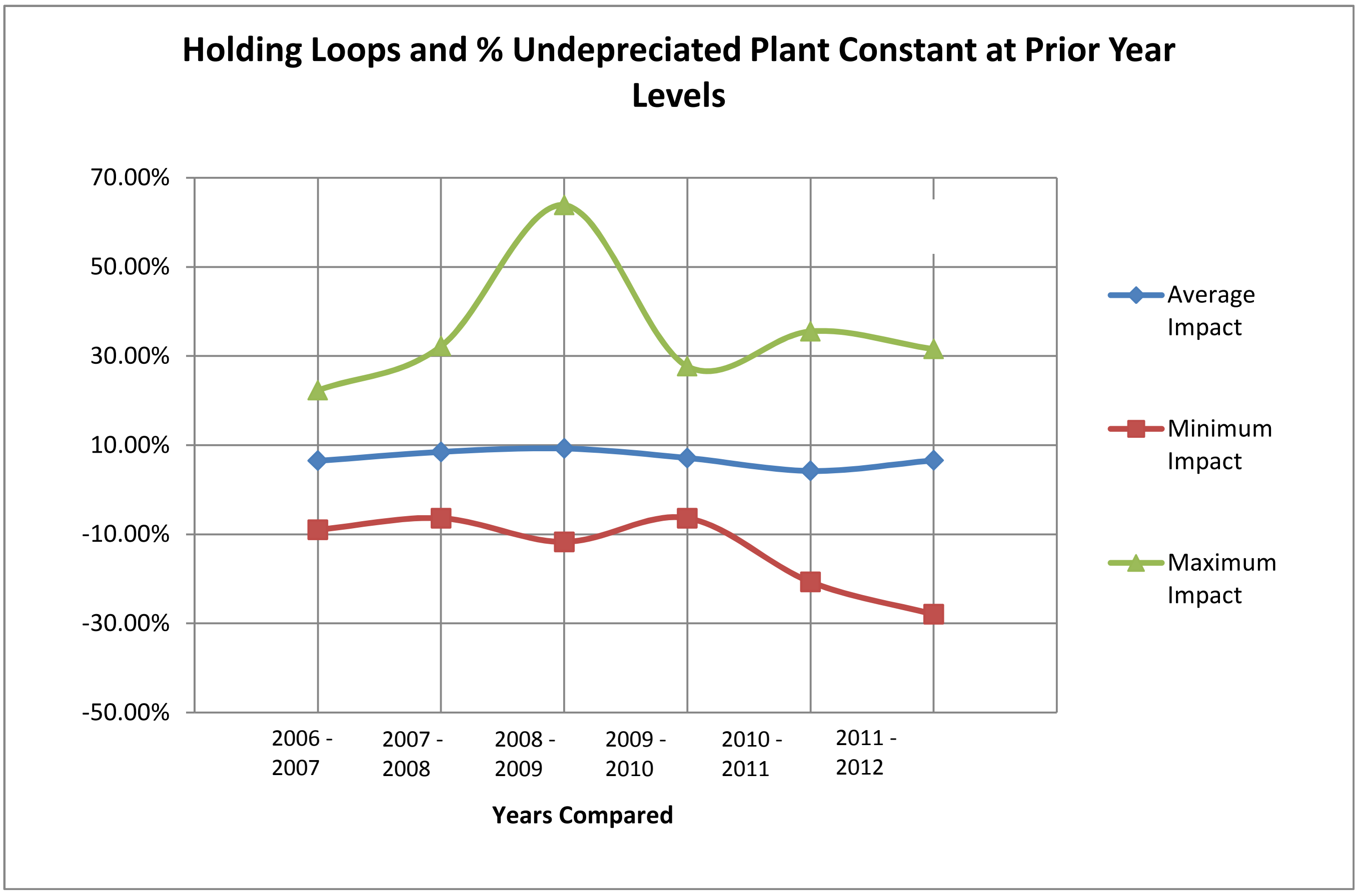
<u>Year to Year Impact of Model Coefficients Updates on Study Areas' Benchmarks</u>

Total Cost Model - Model 6 Structure

Holding Loops and % Undepreciated Plant Constant at Prior Year Levels

% CHANGE IN TOTCOST BENCHMARKs

Number of Study Areas	Years Compared	Average Impact	Minimum Impact	Maximum Impact	Standard Deviation
659	2006 - 2007	6.50%	-8.98%	22.33%	3.04%
678	2007 - 2008	8.48%	-6.40%	32.18%	4.70%
692	2008 - 2009	9.26%	-11.70%	63.85%	7.32%
707	2009 - 2010	7.12%	-6.37%	27.69%	3.59%
722	2010 - 2011	4.22%	-20.70%	35.53%	5.06%
724	2011 - 2012	6.59%	-27.96%	31.53%	6.62%

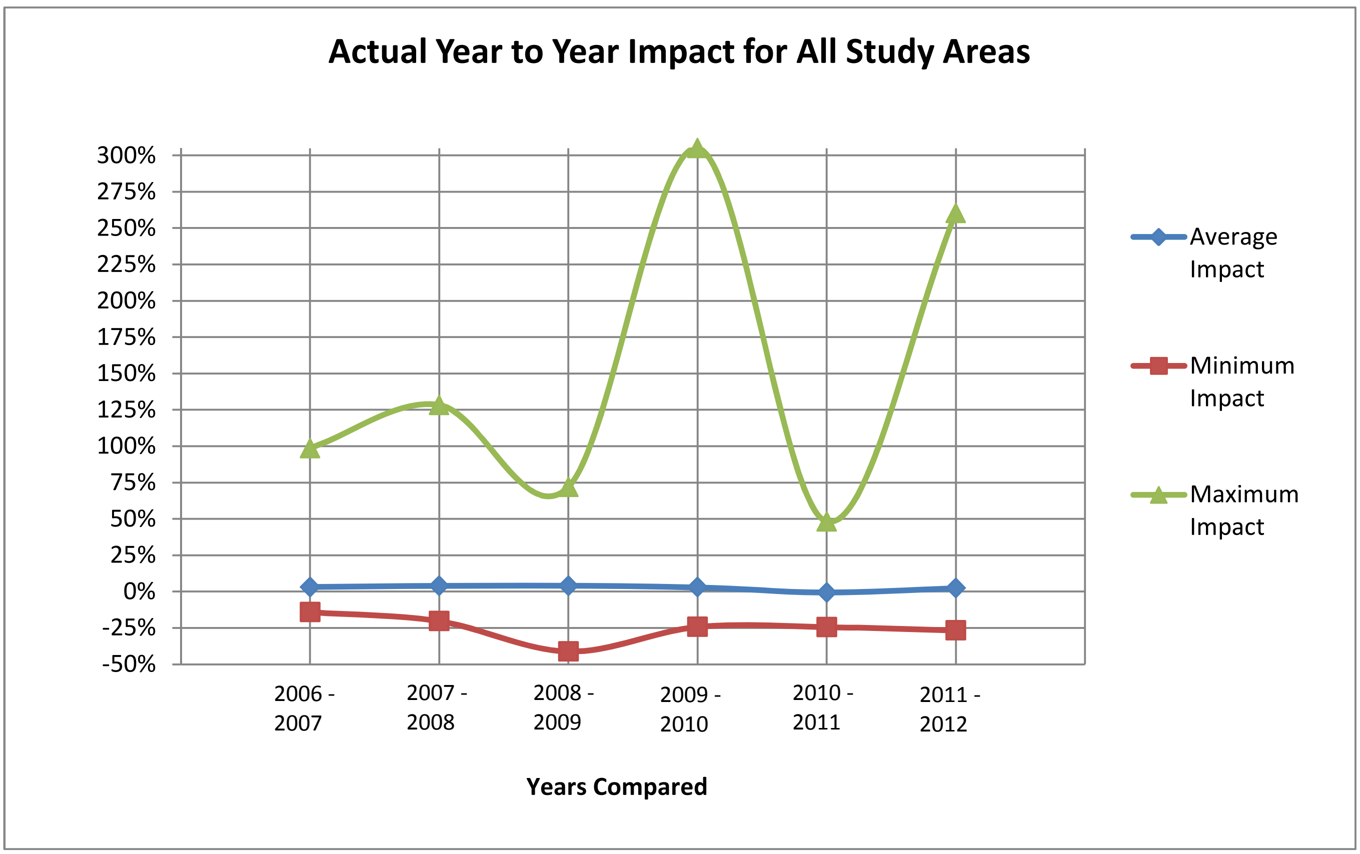


Year to Year Impact of Model Coefficients Updates on Study Areas' Benchmarks

Total Cost Model - Model 6 Structure

Actual Year to Year Impact for All Study Areas

Number of Study Areas	Years Compared	% CHANGE IN TOTCOST BENCHMARKS Average Impact	Minimum Impact	Maximum Impact	Standard Deviation
659	2006 - 2007	3.12%	-14.07%	98.68%	9.32%
678	2007 - 2008	3.98%	-20.36%	128.40%	11.10%
692	2008 - 2009	3.96%	-41.22%	71.90%	12.07%
707	2009 - 2010	3.00%	-24.28%	304.99%	20.58%
722	2010 - 2011	-0.62%	-24.40%	48.16%	9.28%
724	2011 - 2012	2.35%	-26.64%	260.38%	15.02%

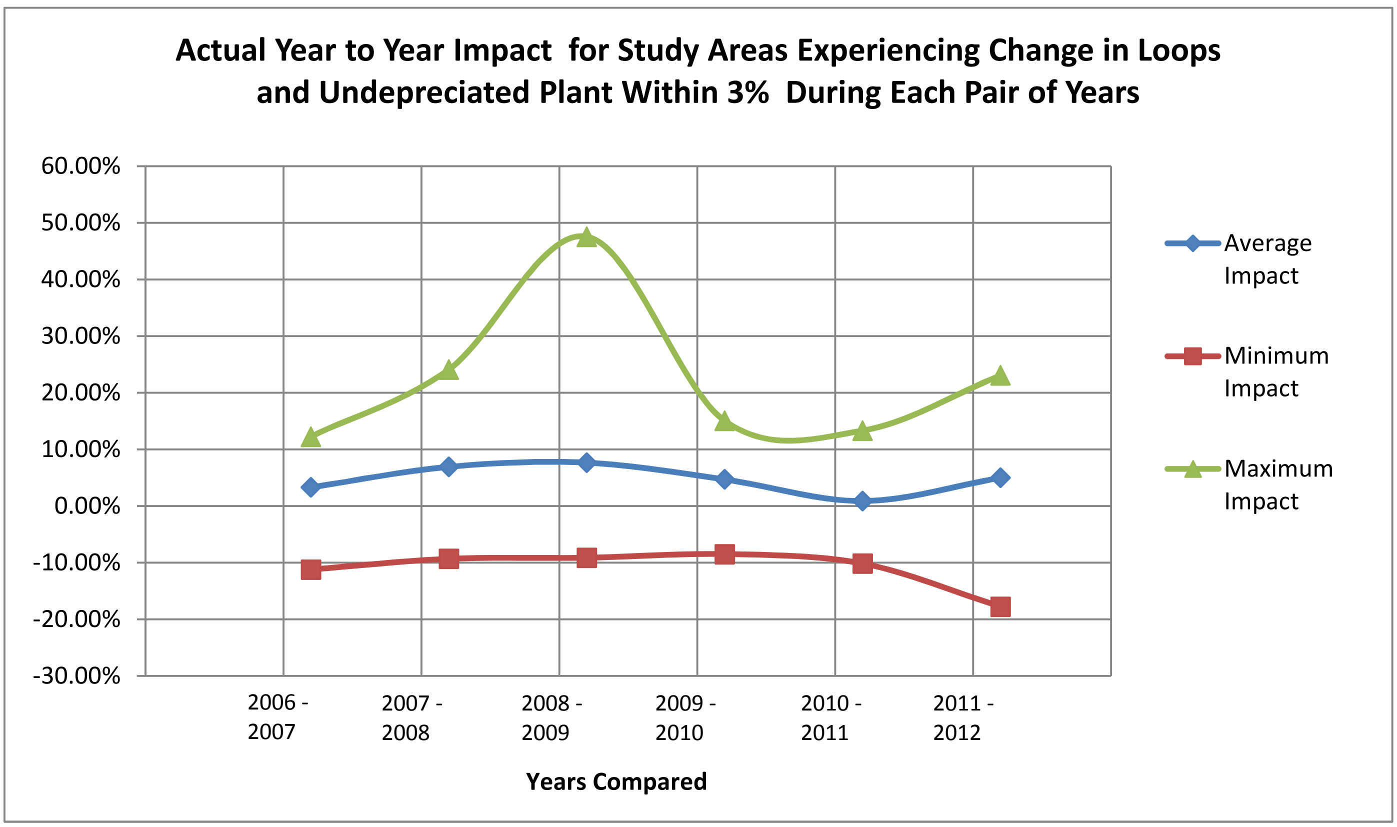


Year to Year Impact of Model Coefficients Updates on Study Areas' Benchmarks

Total Cost Model - Model 6 Structure

Actual Year to Year Impact for Study Areas Experiencing Change in Loops and Undepreciated Plant Within 3% During Each Pair of Years

		% CHANGE IN TOTCOST BENCHMARK			
Number of Study Areas	Years Compared	Average Impact	Minimum Impact	Maximum Impact	Std Dev
225	2006 - 2007	3.30%	-11.20%	12.26%	3.98%
166	2007 - 2008	6.93%	-9.31%	24.12%	5.38%
106	2008 - 2009	7.66%	-9.13%	47.56%	9.26%
81	2009 - 2010	4.69%	-8.49%	15.04%	5.10%
116	2010 - 2011	0.89%	-10.16%	13.33%	5.46%
113	2011 - 2012	4.99%	-17.75%	23.07%	7.49%



Section 4 - Test of Synthetic Similar Situations

This section examines the performance of quantile regression when similarity of situations is induced in the data.

To illustrate, a new 90th quantile model is developed using CAPEX as the dependent variable and only loops as the independent variable. “X” symbols in the first exhibit graph the actual CAPEX data against the loop count data. “+” symbols graph the model values. Comparable results are obtained by using total costs instead of CAPEX without loss of generality.

The first step in inducing similar situations is to create ten replicates of data of each study area, which by definition are absolutely similar. Next, to provide a basis of measuring the success of the quantile regression method in identifying the top ten per cent, variation is induced in each of the 726 situations. The first replicate keeps its value of CAPEX. The second replicate is given a 10% increase over the first. The third is given a 20% increase, and so forth, with the last given a 90% boost over the first. By this construction, each situation includes exactly ten data points, including 10th, 20th, 30th, etc., percentile members. These replicates are evident as stacks of ten X’s in the second exhibit, each stack corresponding to a similar situation.

To improve readability, the third exhibit displays a subset of the similar situations shown in the second exhibit.

The challenge for quantile regression is to find the 90th percenter in each similar situation. This outcome is measured in the fourth exhibit, which summarizes results of eight different quantile models, each relating CAPEX to the sixteen independent variables. The shaded “Original Model” column shows the results of the model based on the actual CAPEX data, replicated as described above. For each of the ten replicate levels, the rows of this column show how many study areas were capped by this model. Among the 726 whose costs were marked up by 90%, 194 were capped. Across other replicate levels decreasing counts of study areas were capped, with six being capped even in the replicate level with no cost markup. Thus, the Bureau’s quantile model succeeds in only 27% of cases in finding the 90th percenters, even when built from data in real similar situations.

To further test the effectiveness of the method, datasets were created which more accurately correlated independent variables with the CAPEX variable. To do so, the residual of each study area’s CAPEX cost from the OLS regression of the same structure as FCC’s quantile model was first calculated. Then a new “Adjusted Actual CAPEX” value was calculated which equaled the model value plus the residual reduced by dividing by 1.2. I.e., this dataset is the same as the original data, but improves the correlation of the CAPEX with the independent variables by 20%.

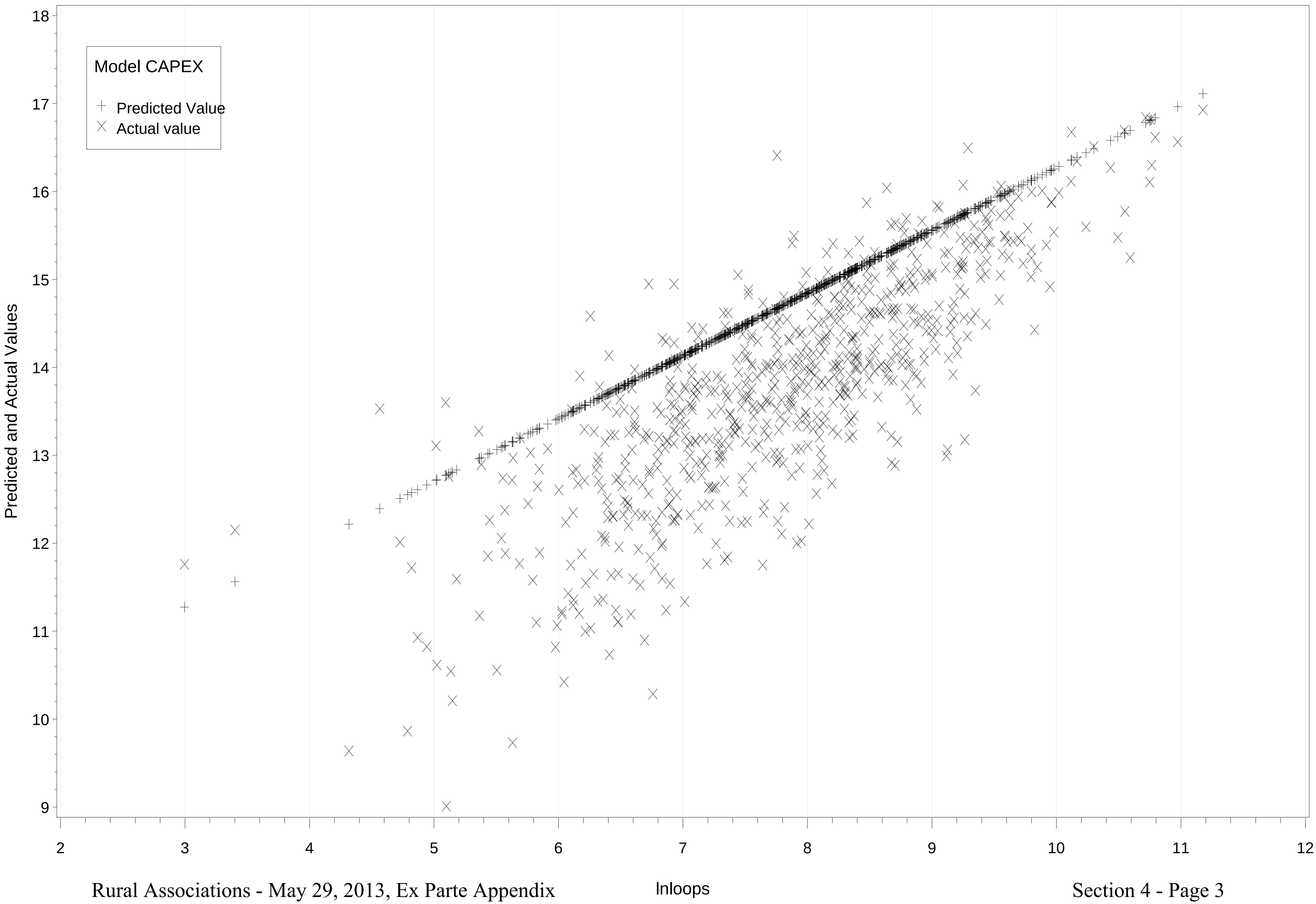
Using this Adjusted Actual CAPEX dataset, the exercise of replicating similar situations was repeated. Results are summarized in the second column of the exhibit. Subsequent columns show residual reductions between 1.5 (one-third reduction) to 50 (98% reduction). Not until the factor reached 5 (an 80% improvement in the fit of the data) did the model succeed in catching more than half of the 90^{th} percenters. To catch all of the 90^{th} percenters, it was necessary to reduce residuals by 98%, producing a near perfect R-squared statistic.

This exercise of evaluating models as described above was repeated for the total cost quantile regression with small modifications and results are shown in the last table. In this simulation, total costs were modeled instead of Capex using the same structure and form of the original FCC Capex model. The dataset was modified to include only study areas that were not impacted by the original FCC quantile model, i.e. 662 study areas below the 90^{th} percentile in the quantile regression with logarithm of total costs as the dependent variable and all 16 independent variables as defined in the FCC model.

Data replications for these study areas were performed in the same way as above, and models with higher degree of goodness of fit were induced by reducing residuals from quantile regression instead of OLS. The results of this simulation are interpreted in the same way as described above. Thirty three percent of the highest cost companies would be clipped by the current model. Also shown for each model are measures of goodness of fit expressed by Pseudo R squared statistics from the logarithmic quantile regression models and recalculated statistics to show how the model outcomes explain variation in the cost per loop. It's worth noting that near perfect or perfect success rate at identifying high cost companies among their peers is not conditioned upon finding a model with perfect fit.

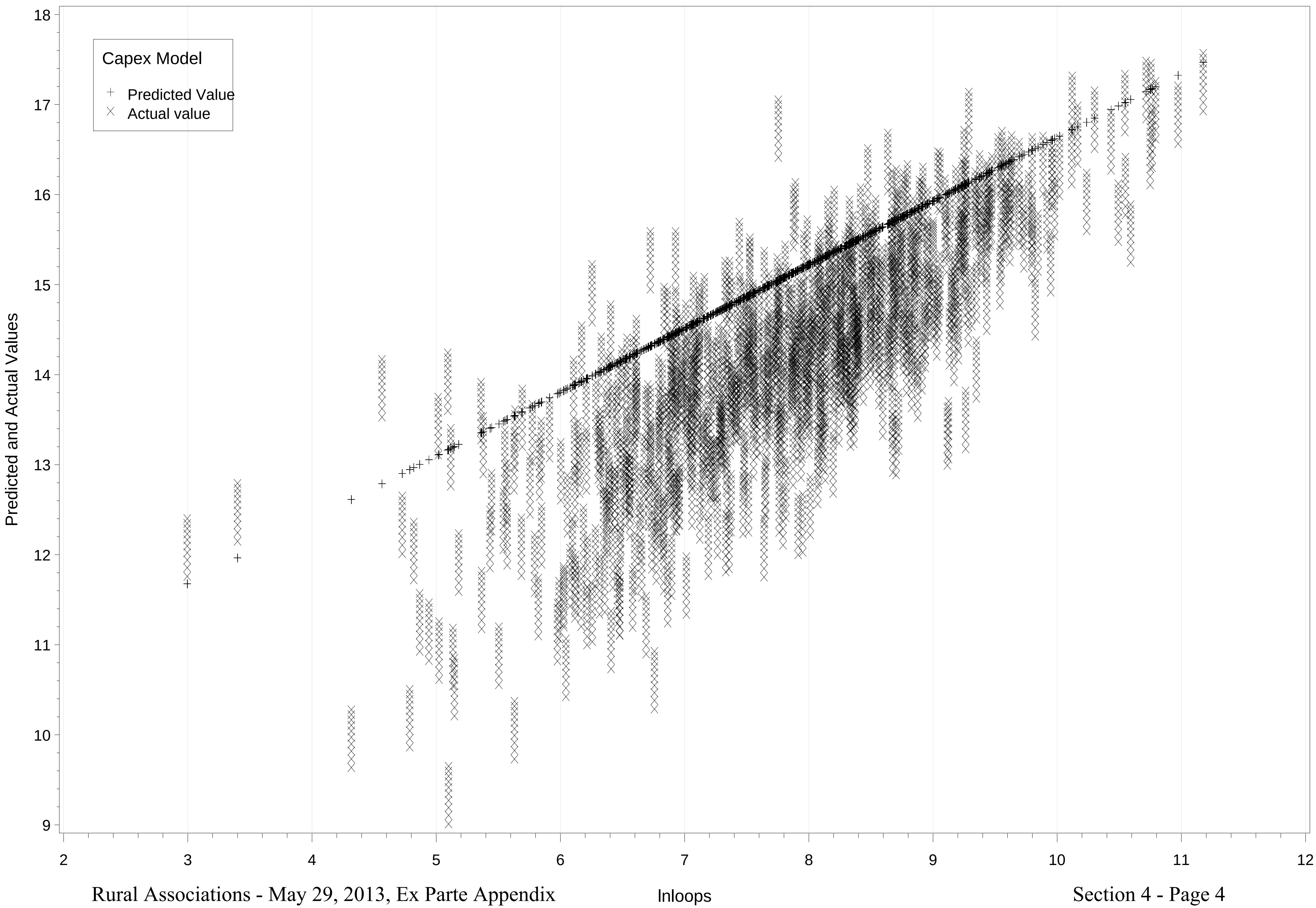
Plot of Actual and Model Values - Original Population of 726 Study Areas

LNCAPEX Versus LnLoops



Plot of Actual and Model Values For Pseudo Population of 7260 (726 groups of 10 similarly situated companies)

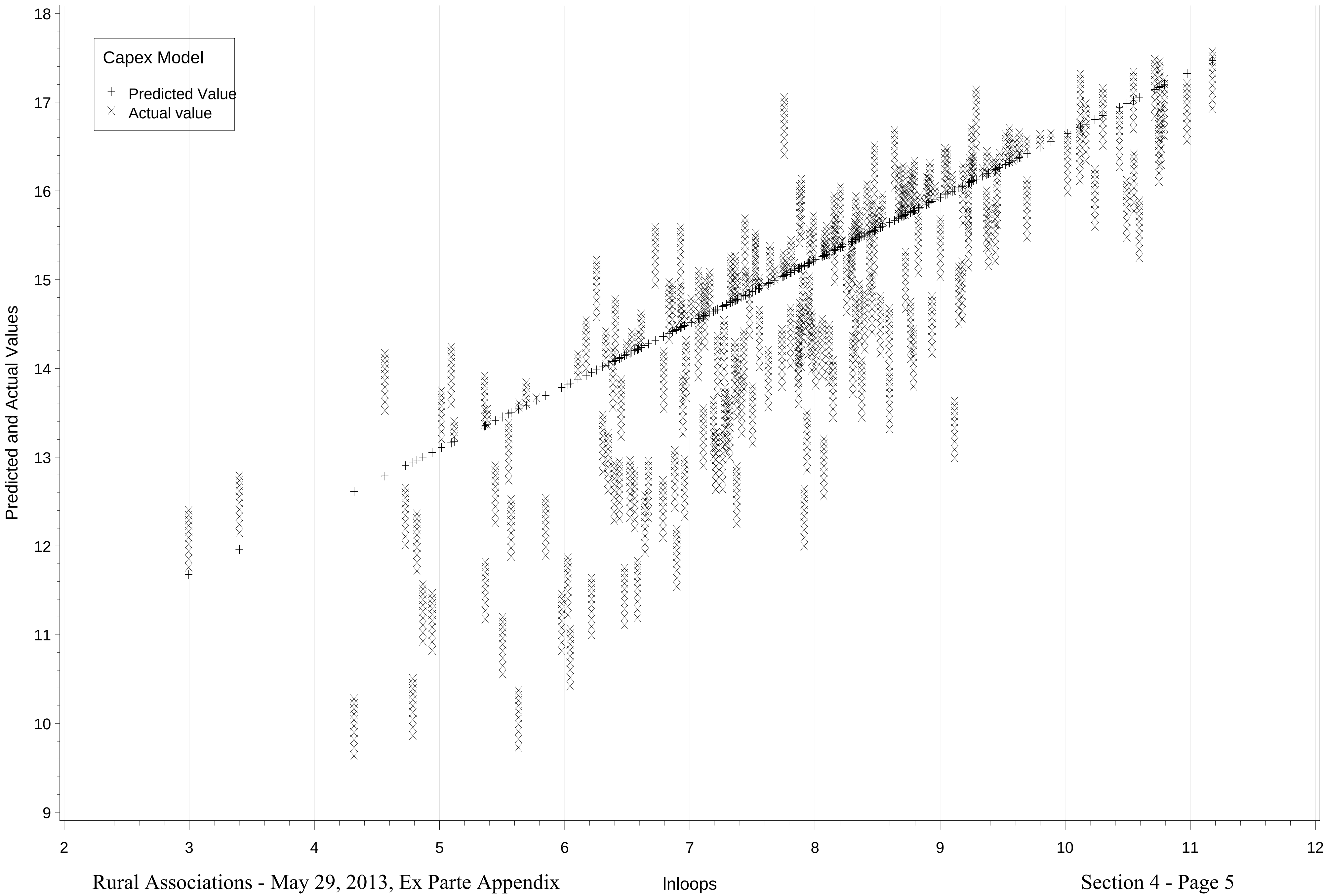
LnCapex Versus LnLoops



Plot of Actual and Model Values For Pseudo Population of 7260 (726 groups of 10 similarly situated companies)

Some Observations in Midrange and Below .9 Quantile Suppressed for Easier Reading

LnCapex Versus LnLoops



Success of FCC Capex Model in Identifying 90th Percenters from True Similar Situations
Similar Situations Formed by Replication

		Residual Adjustjment Divisor						
Factors by which variance around model was reduced	Original Model	1.2	1.5	2	5	10	20	50
R Squared (from OLS regression)	0.879	0.9127	0.9423	0.9667	0.9945	0.9986	0.9997	0.9999
Benchmarked from groups with:								
90% Cost Mark-up	194	205	231	271	414	527	651	725
80% Cost Mark-up	155	166	181	201	224	178	66	0
70% Cost Mark-up	116	121	123	119	62	11	0	0
60% Cost Mark-up	85	87	79	67	16	1	0	0
50% Cost Mark-up	61	56	46	33	3	0	0	0
40% Cost Mark-up	42	33	30	17	0	0	0	0
30% Cost Mark-up	29	25	17	8	0	0	0	0
20% Cost Mark-up	21	14	8	2	0	0	0	0
10% Cost Mark-up	11	8	3	1	0	0	0	0
NO Cost Mark-up (Original Costs)	6	3	2	0	0	0	0	0
90% Cost Mark-up Hits of Total Hits	26.72%	28.24%	31.82%	37.33%	57.02%	72.59%	89.67%	99.86%

Success of FCC QRA Model in Identifying 90th Percenters from True Similar Situations
Models Applied to Groups of 10 Formed from 662 Study Areas Originally Identified as Efficient
(Total Observations in Each Model: 6620)

		Residual Adjustjment Divisor						
Factors by which variance around model was reduced	FCC Model	1.2	1.5	2	5	10	20	50
Pseudo R Squared From Model	0.675	0.706	0.734	0.762	0.802	0.809	0.811	0.817
Pseudo R Squared Recalculated for Cost Per Loop	0.434	0.481	0.530	0.581	0.658	0.672	0.678	0.691
Benchmarked from groups with:								
90% Cost Mark-up	218	234	257	292	429	540	635	662
80% Cost Mark-up	172	183	194	203	198	113	18	0
70% Cost Mark-up	128	128	122	110	25	0	0	0
60% Cost Mark-up	78	68	62	38	0	0	0	0
50% Cost Mark-up	39	30	15	8	0	0	0	0
40% Cost Mark-up	14	9	4	1	0	0	0	0
30% Cost Mark-up	3	2	0	0	0	0	0	0
20% Cost Mark-up	1	0	0	0	0	0	0	0
10% Cost Mark-up	0	0	0	0	0	0	0	0
NO Cost Mark-up (Original Costs)	0	0	0	0	0	0	0	0
90% Cost Mark-up Hits of Total Hits	32.93%	35.35%	38.82%	44.11%	64.80%	81.57%	95.92%	100.00%